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# SECURITIZING ENERGY

## An Integrated Approach Towards a Secure Energy System

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***ABSTRACT***

This study presents policy tools for promoting security of energy supply by integrating quantitative and objective measurements with a more qualitative approach which acknowledges the subjective aspects of policy making. By using text analysis and conducting a literature review, the complex concept of security of energy supply is investigated with some emphasis on recent energy policies within the European Union. Part I deals with the quantitative and objective approach that attempts to measure aspects of security of energy supply to identify threats and vulnerabilities as well as set benchmarks and create inventories. Part II deals with international relations theory and elaborates on two worldviews, *Regions and Empires* and *Market and Institutions,* which influence the perception of threats and the role of actors. Part III integrates the objective and subjective approaches and identifies how the worldview can influence the design or interpretation of quantitative metrics. The EU is also used as a practical example of how uncoordinated attempts by policy makers can result in clashing policy objectives.

*Keywords:* Energy Security – Energy Policy – Quantitative Indicators – International Relations – EU

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## FIGURES



## EQUATIONS

# ABBREVATIONS

AHP – Analytical Hierarchy Process

APEC – The Asia Pacfic Economic Cooperation

APERC – The Asia Pacific Energy Research Centre

CIEP – Clingendael International Energy Programme

DoC – Domestic Oil Consumption

DoR – Domestic Oil Reserves

ECN – The Energy research Centre of the Netherlands

ESSD – Energy Security and Sustainable Development

EU – European Union

GDP – Gross Domestic Product

GOMCR – Geopolitical Oil Market Concentration Risk

GoR – Geographical Oil Risk

ICRG – The International Country Risk Guide

IEA - International Energy Agency

IMF – International Monetary Fund

MI – Markets and Institutions

ML – Market Liquidity

NATO – North Atlantic Treaty Organization

NGO – Non-Governmental Organization

OI – Oil Intensity

OPEC – Organization of the Petroleum Exporting Countries

OVI – Oil Vulnerability Index

PES – Primary Energy Supply

RE – Regions and Empires

S/D – Supply and Demand

SoS – Security of Supply

TPES – Total Primary Energy Supply

UN – United Nations

UNDP – United Nations Development Programme

WTO – World Trade Organization

WTP – Willingness To Pay

# INTRODUCTION

A common approach towards understanding security of energy supply[1] is by using quantitative measurements and indicators in order to establish inventories and benchmarks of the state of the energy system.[2] The objective outcomes of these measurements could then serve as guiding principles for policy makers in their attempts to reduce vulnerabilities and mitigate risks of disruptions in the energy supply.[3] Lately, however, scholars within the field have been calling for a broader and more encompassing definition of the concept which is difficult to reach through quantitative models, arguing that security issues are always part of a subjective process filled with interpretations and perceived threats.[4]

As a result of the different views on what security of energy supply actually refers to, what it consists of and how it can be achieved, numerous definitions appear throughout the literature, confirming that little consensus exist on the matter. One of the most common definitions is provided by the International Energy Agency (IEA) who argues that energy security can be described as ”the uninterrupted physical availability at a price which is affordable, while respecting environmental concerns.”[5]

A second approach is to address the risks of energy *in*security and the possible loss of welfare that may occur as a result of a change in price or availability of energy.[6] Either way, acknowledging the impacts on the economy in cases of supply disruptions is a common theme in many of the definitions.[7] However, these definitions do not account for the view that nations' own perception of security of energy supply is formed through a subjective process dependent on e.g. historical actions and strategies of the nation as well as the causes and origins of the insecurity.

This study aims at identifying policy tools and strategies to use when addressing security of energy supply. A second aim can also be found in the attempt to pinpoint possible contradictions and inconsistencies in energy policies by using recent directives within the European Union as examples of a narrow-minded approach to the concept. This will be achieved by conducting a literature review and a full explanation of the methodological considerations are provided in Appendix A.

Before identifying policy tools, two steps need to be taken in order to gain the deeper understanding of security of energy supply this thesis calls for. The outline will be as follows:

Part I will address the identification of threats and vulnerabilities by using quantitative and objective tools which take the unique settings of a nation's energy system into consideration. These tools are crucial for establishing inventories and benchmarks of the energy system in general, and the security of supply in particular. A framework will be provided upon which the quantitative indicators and measurements for addressing security of energy supply are evaluated.

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[1] The concept is also referred to as 'energy security'. This thesis uses the concepts interchangeably, and does not distinguish between the two.

[2] See e.g. Hughes & Shupe (2010) *Creating Energy Security Indexes with Decision Matrices and Quantitative Criteria*; Kruyt et al. (2011) *Indicators for Energy Security*

[3] van der Linde et al. (2004) *Study on Energy Supply Security and Geopolitics*

[4] See e.g. Goldthau (2011) *The Public Policy Dimension of Energy Security;* Valentine (2011) *The Fuzzy Nature of Energy Security.*

[5] IEA Web. *Energy Security*

[6] Ölz et al. (2007) *Contribution of Renewables to Energy Security*

[7] For a comprehensive table of the definitions found in the literature see Sovacool (2011) *Introduction*.

In Part II, attempts are made to fill in the blind spots and gaps that become evident when complex issues such as energy security are quantified. This part takes a subjective approach by emphasizing the role of worldview and perception of the international system held by policy makers. Based on theories of international relations, a framework will be developed and the two approaches – "Regions & Empires" and "Markets & Institutions" – are presented which provide insights in which the various actors are, and how they can be perceived.

Part III identifies the tools available for policy makers when addressing security of energy supply. However, the tools depend on an integrated approach combining objective and subjective approaches to security of energy supply. An example will be made out of recent energy policies within the European Union to identify how clashes and contradictions can exist in practice if a coordinated approach is not followed.

# I. IDENTIFYING VULNERABILITIES
## – QUANTITATIVE INDICATORS AND MEASUREMENTS

To be able to identify threats and vulnerabilities in terms of security of energy supply several quantitative indicators have emerged in the literature claiming to be objective measurements. These however critically hinge upon assumptions regarding the boundaries of the energy system (including sub-systems), such as substitutability, time scale as well as how to characterize a secure energy system as opposed to a non-secure energy system.[8] Part I will attempt to develop a framework and evaluate a few quantitative indicators that are present in the relevant literature.

The importance of quantitative indicators for security of energy supply goes beyond that of academic research; they exist in an attempt to create a standard that would allow jurisdictions such as the European Union to be able to assess their energy supply security in order to adapt national or regional energy policies. A report by the Cligendael International Energy Programme (CIEP)[9] states that, in order to design policy as well as determine the vital energy interests, a jurisdiction needs to determine the robustness or strength of its energy systems. In other words be able to assess what vulnerabilities and threats exist.

Hence, the report argues that jurisdictions should create an *inventory* of existing policy measures (e.g. internal energy market policy; environmental policies; energy security policies; foreign and security policies). Furthermore, inventories are also needed to address current energy demand and demand-switching capabilities. What is important in this approach, a fact that this thesis also builds upon, is that these types of inventories are necessary to be able to construct a coherent energy security policy.[10] Stressed in this thesis, however, is that these indicators and measures, even though being one of the first steps in evaluating the security of energy supply and creating the necessary inventories, is not the only step. It is important to recognize what knowledge can be extrapolated from using the measures and of equal importance, what is excluded from them.

The purpose of this section is twofold; *i)* to provide a framework to evaluate and understand the indicators of energy security supply and *ii)* to describe some of the various aggregated quantitative indicators that exist and illustrate the strengths and weaknesses of each measure in its attempt to quantify security of energy supply. A focus will be kept on those aggregated indicators which address long term security of energy supply.[11]

### The Four A's – A Framework for Understanding Energy Security

The Asia Pacific Energy Research Centre (APERC) is a research body affiliated with the Institute of Energy Economics, Japan. The mission of the organization is to "foster understanding amongst APEC economies of global, regional and domestic energy trends, energy infrastructure development, energy regulatory reform, and related policy issues."[12]

[8] Cherp & Jewell (2011) *Measuring Energy Security: From Universal Indicators to Conceptualized Frameworks*
[9] van der Linde et al. (2004)
[10] van der Linde et al. (2004)
[11] Simple indicators capture one aspect of security of energy supply, whilst aggregated indicators capture various aspects in a single index or indicator.
[12] APERC Web. *About APERC.*

In an oft-cited study[13] scholars have designed a framework referred to as the *Energy Security and Sustainable Development* (ESSD) framework, which builds on the notion of four A's; Availability, Accessibility, Affordability and Acceptability (as illustrated in figure 1.1 below). A brief overview on the framework and its relevance regarding security of energy supply will be provided below.

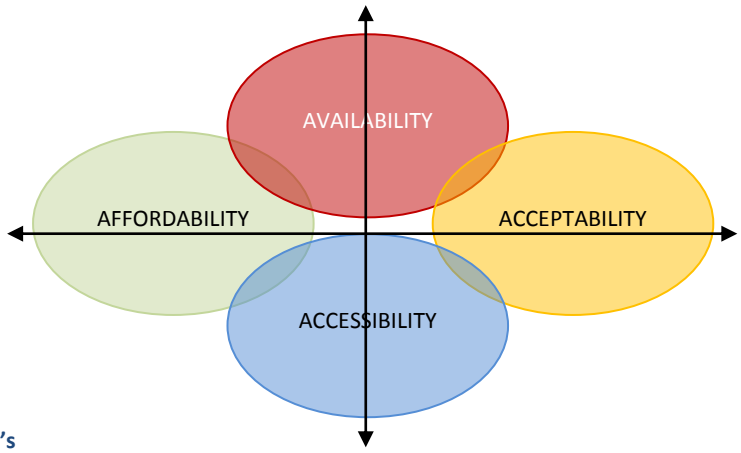


**Figure 1.1 – The Four A's**
***Source: Kruyt et. al. (2009)***

## *Availability*

Within the APERC report the concept of availability is confined to oil and other fossil fuels. It refers to the "amount of supply of a given primary energy resource in terms of known reserves."[14] This definition is considered narrow as it includes only geological resources such as fossil fuels and radioactive material for sources of primary energy resources.[15] Today the concept must include other primary energy sources such as hydroelectricity, biomass, solar and wind energy. The availability of a primary energy source is also influenced by factors such as energy infrastructure and energy transportation infrastructure. [16]

## *Accessibility*

Accessibility is used to describe the barriers that exist in the procurement of primary energy resources. This refers to the geopolitical elements which make accessibility difficult to measure. Also included are geographic factors, since APERC are focusing on fossil fuel supplies and mainly oil sources they point out that current reserves and untapped reserves are in particular isolated locations such as deep sea or arctic regions making it difficult to extract.[17] The difficulties in accessing these resources have both a political as well as a physical dimension, illustrating the possible overlap between availability and accessibility.

The biggest constraint when it comes to other primary sources, such as renewables are high initial capital costs required for large projects. To promote accessibility through the use of renewable energy, various governmental incentives are important (e.g. feed-in tariffs, net-metering, and tax credits).[18] Labor force constraints also have an influence on accessibility, illustrating the broad nature of this concept as it also includes social, economic and environmental factors.[19]

[13] APERC (2007) *A Quest for Energy Security in the 21st Century*
[14] Hughes & Shupe (2010)
[15] Hughes & Shupe (2010)
[16] Hughes & Shupe (2010)
[17] APERC (2007)
[18] APERC (2007)
[19] Indriyanto et al.(2011)*The Sustainable Development Dimension of Energy Security*

### *Affordability*

Affordability within the APERC report refers mainly to fuel prices and cost of infrastructure. The concept can be expanded to include the cost of energy services and the cost to the consumer at a specific time.[20] This can be seen as the energy price and how if effects the households. Affordability also brings up the topic of energy poverty; as economic affordability means that even the poorest segment of a population are supplied with energy at prices that are affordable to them. In instances where the poorest segments of the population are not supplied with reliable affordable sources of energy, energy poverty is seen to exist.[21]

### *Acceptability*

When referring to acceptability the main concern is regarding the environmental acceptability of the resource. The APERC report analyses this in terms of sequestration of coal, nuclear and unconventional fuels. The way that APERC goes to analyze the topic is by seeing how changes in tax mechanisms for fuels will influence the security of supply of a given resource. However this is a little narrow and it would be beneficial to include social and political issues that are prevalent in a certain region. [22]

### *Concluding Remarks Regarding the Four A's*

The four A's provide an over-arching method to try and capture the various aspects of energy security. It provides broad categories that are not isolated from one another, but which still show distinct aspects of energy security as a whole. [23] This is probably clearest through the murky boundaries between accessibility and availability.

APERC attempts to identify and categorize the relationships between supplier and consumer nations as well as the transit countries. It also attempts to identify how the energy market influences prices and affects the affordability for households. The A's also point out that the energy market is influenced by geo-political elements. Through the recent discussions in Copenhagen and future conferences one can also see geo-politics in practice in the promotion of sustainable practices and energy production/usage.

As mentioned the four A's is an over-arching method as they provide rough guidelines for a review of energy security for different sources of energy. To be able to review security of energy supply, the various aspects of the four A's need to be quantified in an objective manner and this is where the task becomes difficult. Many concepts are highly qualitative in nature, such as the geo-political relationships between nations or measuring the acceptability of energy sources. This is why this paper calls for a synthesis between international relations theory and quantitative methods of explaining security of energy supply to ensure that policy decisions are made whilst taking all relevant knowledge into consideration. The following section will describe a few quantitative indicators currently present in the literature, chosen on the basis that they are comprehensive in their approach, as well as widely used throughout the literature.

[20] Hughes & Shupe (2010)
[21] Pachauri (2011) *The Energy Poverty Dimension of Energy Security*
[22] Hughes & Shupe (2010)
[23] Kruyt et al. (2011)

## Indicators and measurements in security of energy supply

It should be noted that a valid indicator or measure (in general) should have "criteria, metrics and methods" which are "justifiable, understandable and reproducible."[24] *Justifiable* implying that there is good reason for the variables chosen and the design of the models, *understandable* in terms of the transparency of the model and if the results are communicated clearly, and *reproducible* in terms of how easily the results can be duplicated. Moreover since the four A's can be seen as an over-arching framework for energy security, a good indicator of security of energy supply should be able to account for the four A's as well as meeting the criteria for a good indicator. It is upon these criteria that the measures will be discussed and evaluated.

### Oil Vulnerability Index

The importance of oil as a major energy source cannot be ignored. For this reason an Oil Vulnerability Index (OVI)[25] is created that solely measures the sensitivity of economies to changes in the global market, or as the names suggests the vulnerability associated with oil. Therefore what can be extrapolated from this measure is how vulnerable, or under risk from an oil shock (supply or price) an economy is.

It is stated that there are three major risks associated with oil;

- **Market (economic) Risk**- these risks relate to the effects on nations at a macroeconomic level with regards to changes in the oil market and measures market vulnerabilities through the following variables;
    - GDP per Capita at Market Exchange Rate
    - Oil Intensity at Market Exchange Rate (OI)
    - Cost of oil in National Income
    - Oil Share
- **Supply Risk**- this is simply with regard to the physical aspects of being able to acquire/supply oil and measure supply vulnerabilities through the following variables;
    - Domestic Oil Reserves relative to total Domestic Oil Consumption (DoR/DoC) – this is the ratio of oil reserves to domestic oil consumption and is negatively related to oil supply vulnerability.[26]
    - Geographical Oil Risk (GOR) – this is the exposure an economy has to geopolitical risks and is defined as "exposure of an economy to physical supply distortions due to strategically motivated control of supply by oil exporting countries or breakdown in political and economic systems."[27] This is done by using four indicators which can be divided into two sub-categories.
        - Geopolitical oil market concentration risk (GOMCR), which consists of;
            - Net-oil import dependence of an oil-importing country,

[24] Hughes & Shupe (2010, p. 2)
[25] Gupta (2008) *Oil Vulnerability Index of Oil-importing Countries*
[26] Gupta argues that the reserves to production ratio is not used as it gives an unclear picture due the fact that countries such as those within the EU have low reserves and low production, resulting in high reserves to production ratios. However by keeping the ratio in regards to consumption, Gupta feels the ratio has more explanatory power.
[27] Gupta (2008, p. 1198)

- diversification of oil imports
- political risk in supplying country

  These variables are accounted for using the Herfindahl-Hirschman Index[28].

  - Market Liquidity (ML)

- **Environmental Risk**- this takes into consideration a wide range of risks such as those associated with climate change, global warming, accidents as well as emissions related to oil usage. However these risks are not taken into consideration in the original analysis and can be considered a major weakness in the model.

To obtain the final equation below many steps are taken and use is made of the statistical technique, principal component analysis.

$$OVI_K = \frac{\lambda_1 P_{1K} + \lambda_2 P_{2K} + \lambda_3 P_{3K} + \lambda_4 P_{4K} + \lambda_5 P_{5K} + \lambda_6 P_{6K} + \lambda_7 P_{7K}}{\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7}$$

- *OVI- Oil Vulnerability Index for country K*
- *λ- Principal Components (=var ($P_j$))*
- *P- Product of standardized indicator vector and $F_j$*

**Equation 1.1 - Oil Vulnerability Index**
***Source: Gupta (2008)***

Although very complex and technical, if one were to use this model with different scholars but the same data, the results would be replicated. This is due to the fact that the metrics and variables are based on solid objective and quantitative data. This is even true for the political risk, as the model utilizes the International Country Risk Guide (ICRG) data which is used to take political risk into consideration.

In terms of understandability this model suffers. It is very unclear from the final model what is truly being represented and how the various variables influence the final OVI value. The mathematical and statistical techniques are complex with many steps resulting in a loss of transparency in the model. It is easy to understand that a higher level of vulnerability implies lower levels of security of energy supply, but the reasons for this are not communicated clearly from the model and the effects of each risk outlined above on the final figure is unclear.

Although it is a criticism that the model only applies to oil, the model is justifiable for what it wishes to do. In terms of measuring the vulnerabilities towards oil, there is use of strong quantitative data providing a good solid base in terms of the metrics used to create the model. However the complete exclusion of the environmental risk is problematic but can be argued as to being difficult to quantify and therefore warranting exclusion from the model. Moreover the ICRG data accounts for twelve various variables and excludes the strength of multilateral or bilateral relationships, which can be seen as a limitation.[29]

[28] Rhoades (1993) *The Herfindahl-Hirschman Index*
[29] ICRG weights and includes; government stability, socioeconomic condition, investment profile, internal conflict, external conflict, corruption, military in politics, religious tension, law and order, ethnic tension, democratic accountability and beaureacratic quality.

The model attempts to focus on the **affordability** and **accessibility** aspects of security of energy supply. Affordability is mainly accounted for through the various market risk metrics as well as the market liquidity metric forming a part of the supply risks. Accessibility is accounted for through the supply risks, such as geopolitical market concentration risk but mainly through the ICRG data. The metrics used to account for these are well designed but cannot be seen as being able to account for all aspects of geo-politics, ignoring aspects such as bilateral or multilateral relationships. This is understandable as this thesis constantly points out that quantifying these aspects is difficult and one of the main problems with attempting to quantify security of energy supply. Acceptability is completely ignored in this model, as earlier mentioned regarding the environmental risks not being included in the model. Availability is accounted through the supply risks, by including DoR/DoC, as well as the net import dependency.

Overall the model provides good information regarding the vulnerabilities associated with oil, which is one of the most used and transferrable energy sources available. It makes a strong attempt to include geo-political elements by using ICRG data which although well compiled also reduces transparency and ignores important aspects of how the oil demanding nations perceives the state of the world and its own role in this world. This model also provides little information to policy makers as to what is truly influencing the level of vulnerability due to the lack of transparency. The ability to create an inventory of demand-switching capabilities is limited but it is able to account for demand regarding oil. It can show a policy maker that action needs to be taken, but not necessarily what actions would be best. The model provides a good indication of vulnerability regarding oil, but it is limited to that. It allows for benchmarking and indicating vulnerabilities and could be a tool to aid in designing policy but to use the indicator on its own could result in misinformed decision making.

### Willingness to Pay

The Willingness to Pay model does not identify the state of the energy system, nor the security of energy supply but rather attempts to put in monetary terms, the willingness for jurisdictions to pay in order to avoid security of energy supply risks. This calculation is dependent on four main variables; dependency on oil or gas; the share of the particular fuel in total consumption with total consumption of primary energy sources; energy intensity per unit of GDP; the amount of investments to improve levels of energy security. This forms a small part of a larger model that was developed by *Bollen et al.*[30] utilizing the MERGE model as his basis. In this section we will only focus on the willingness to pay function.

Through various mathematical procedures[31] the equation (1.2) presented below is developed. The penalty variable which expresses the willingness to pay to avoid a lack of security of energy supply in % terms of generic consumption is described as;

$$\Omega_{t,r} = \theta_{t,r}\left(\frac{i_{t,r}}{i_{0,r}}\right)^{\alpha}\left(\frac{c_{t,r}}{c_{0,r}}\right)^{\beta}\left(\frac{e_{t,r}}{e_{0,r}}\right)^{\gamma}$$

*$\Omega$ - penalty function expressing willingness to pay*
*$\theta$- overall region-dependent scaling factor*

[30] Bollen et al. (2010) *An Integrated Assessment of Climate Change, Air Pollution, and Energy Security Policy*
[31] For the complete process see Bollen et al. (2010)

*t- time aspect*
*r- region aspect*
*$i$ - import ratio of the fuel*
*$c$ -the share of fuel in the TPES, consumption ratio*
*e- energy intensity, consumption of energy per unit of GDP*
*$\alpha, \beta, \gamma$- exponents regarding the nature of the dependency of $\Omega$ on these variables*

**Equation 1.2 - Willingness to Pay – Penalty Function**
***Source: Bollen et al. (2010)***

It is important to point out that the model only looks at fossil fuels as it is used only for oil and gas on the basis that these two sources are perceived to be the greatest threat to energy security.[32] This can also be a criticism as to the justifiability of the model and its ability to accurately describe the willingness to pay to avoid a lack of security of energy supply. It however is able to account for three diversification strategies through the WTP equation; (1) the supply portfolio of a given energy commodity; (2) the energy portfolio; (3) the production factors, providing valuable information to this regard. [33]

In terms of the measure being reproducible, the results can easily be duplicated. There is quantitative data for each of the main variables that are used in the measure, including the scaling factor. This does not mean the definition for each variable is perfect but rather it can be easily duplicated if the same data were to be used by another scholar. The speculative nature of the scaling factor is problematic as is the way in which the exponents are defined.

The variables are also transparent, it is easy to observe the working of the model and although one can benefit from previous knowledge of the model (starting from the MERGE model) it is not necessary for understanding the willingness to pay function. However not so clear is what the model truly describes, the willingness to pay to avoid security of energy supply disruptions is a little vague and requires understanding the way by which the model was designed. Again due to some of the broad definitions used the understandability is reduced (e.g. what does the regional scaling factor and exponents truly communicate.)

In terms of justifiability, the choice of variables follows logical reasoning. However it may lack in justifiability in dealing with only oil and gas. These variables, although very important for the transport sector, can vary intensely depending on the nation in question regarding the importance for the energy system as a whole. The choice in the construction of some variables is also detrimental to the justifiability of the model. The scaling factor is chosen whilst keeping in mind past investments related to improvements in energy security made by the nations.[34] This method of choosing the scaling factor is speculative, leading to the author behind the model's own admission that this can be seen as a weakness[35]. The assumptions regarding the exponents is also problematic simply basing the values on the assumption that the risk associated with each variable increases at a faster rate than the dependency but the values are chosen arbitrarily. Therefore it seems as though justifiability is problematic with this measure.

[32] Kruyt et al. (2011)
[33] Bollen et al. (2010)
[34] Kruyt et al. (2011)
[35] Bollen et al. (2010, p. 4024)

In terms of the four A's the willingness to pay in its attempt to place security of supply in monetary terms deals with **affordability,** answering the question as to how much a jurisdiction is willing to pay to avoid a disruption in supply of oil or gas**.** The exponents represent the 'nature of the dependency', although this could include geo-political elements it is not made clear. It seems as though the scholars acknowledge the fact that there are factors at play which cannot be observed through quantitative data but does not specify what these are to represent exactly, other than the nature of the dependency. Acceptability is not included anywhere in the model and can be seen as being ignored. Availability can be seen to be accounted for through the import ratio but only for oil and gas, ignoring other potential energy sources. Therefore the model seems to only represent two out of four A's.

The main criticism lays with the way certain variables values are arbitrarily selected, a weakness the scholars recognize and the ability to only account for two of the four A's. Although this model provides insights into the nature of existing energy systems and the state of three diversification strategies, it is not able to provide an accurate inventory of policies and demand (it only focuses on oil and gas) but is able to identify vulnerabilities. Thus there is little one can gain in an attempt to improve the process of policy design from this measure but a high willingness to pay is indicative that something needs to be done.

## Decision Matrix

| | $w_1$ | ... | $w_c$ | | |
|---|---|---|---|---|---|
| | $C_1$ | | $C_c$ | | |
| $A_1$ | $r_{1,1}$ | | $r_{c,1}$ | $v_1$ | $v_1 = w_1 \times r_{1,1} + \ldots + w_c \times r_{c,1}$ |
| ... | | | | | |
| $A_2$ | $r_{1,a}$ | | $r_{c,a}$ | $v_a$ | $V_a = w_1 \times r_{1,a} + \ldots + w_c \times r_{c,a}$ |

**Figure 1.1 - Decision Matrix**
***Source: Hughes & Shupe (2010)***

Utilizing the concept of the analytical hierarchy process (AHP) and a decision matrix to create an index,[36] this model's aim is to provide several blanks which can be filled up by scholars conducting individual studies. Therefore this matrix is in a way a "skeleton" upon which case studies can be built and the individual components modified depending on the nature of the study.

The matrix results in an individual index for each alternative (A) that is identified by experts. Each alternative is ranked (r) based on appropriate metrics and weighted (w) based upon certain criteria (C).

The result is a final vector where an index for each alternative is derived. The individual index is the sum of the rankings multiplied by the weights for each alternative. The interpretation of the index is dependent on the metrics used.

[36] Hughes & Shupe (2010)

*Alternatives*

These can be identified as "any group of related energy supplies, services, or infrastructure that is necessary for the functioning of the jurisdiction."[37] This could be for example, coal, nuclear, oil, natural gas etc. This can be done quantitatively if data is used to determine important energy sources, or most used infrastructure. The problem lies with the fact that it can be based upon expert judgment or what an individual study is looking to examine, be it oil, gas, or heating etc.

*Criteria*

The criteria are linked to the alternative in a way that it explains part of the alternative. Using the concept of the A's, five criteria are established each with its own metrics. These include availability, temporal (over time) accessibility, current accessibility, affordability and acceptability.

*Metrics*

Metrics are used to measure the various criteria. It is stated that qualitative metrics should be based on expert judgment, which is a criticism that the authors acknowledge. This method may provide consistent results but at the same time not be reproducible with another group of experts. It is therefore recommended that quantitative data is used if possible. The individual metrics depend on the alternatives and are up to the scholar to select from the possible indicators that are available in various literatures. This allows for a large amount of flexibility when designing a study utilizing the decision matrix.

*Weighting*

Based upon the analytical hierarchy process the weights are determined by experts who understand the relationship that exists between the criteria and the impact that it can have on a jurisdiction. Although qualitative in nature, the weights attempt to weigh the nature of the relationship between a jurisdiction and criteria. This can be problematic as the effectiveness of the weighting to capture the relationship also depends on the design of the metric.

The largest problem with this model is the ability for results to be replicated. Expert judgment is required on at least two stages when choosing the alternatives and the weightings, more depending on how the metrics are designed. This can be done quantitatively as well however due to the open nature of the model it is dependent on the individual scholar conducting the study.

The model is very understandable and quite transparent. The workings of the model are clear and individuals can see how each alternative and criteria effects the end value of the index. However the individual metrics used for the various criteria are not represented within the matrix and not necessarily clearly observable however as earlier mentioned they change for each study.[38] The fact that metrics will change for each study is also a strength as this allows flexibility in the design of a study in order to be able to capture the various relationships between alternatives and criteria adequately. The way by which the weights are assigned is not clear unless there is an experts report or other way of reviewing exactly how the weights are assigned.

[37] Hughes & Shupe (2010, p.6)

[38] In his own study, Hughes does provide details regarding the specific metrics used in the case study.

A decision matrix is justifiable; it is a clear and concise way of depicting information regarding security of energy supply. Utilizing the four A's as a basis for the criteria is also justifiable as it encompasses the various aspects of energy security. The justifiability will need to be analyzed for each study individually; this is due to the fact that the various elements of the matrix can change according to each case. Therefore justification needs to be reported for the weightings, the selection of alternatives and each metric for studies utilizing the decision matrix as a basis for analysis.

This matrix attempts to encompass all of the A's as it is the basis upon which the criteria are designed. Regarding specifics it depends on each individual study and the adequacy of the metrics utilized to be able to determine whether the A's are truly represented. For this reason it is also difficult to determine how the model deals with geo-political elements. The case study that Larry Hughes conducts is at a consumer level and therefore ignores geo-politics and utilizes changes in demand for each energy alternative. Such a metric may prove to be inadequate in dealing with accessibility at a national level[39]. Saying this, utilizing the matrix would provide a good in-depth inventory of policies and energy demand and demand switching capabilities and therefore prove helpful in designing energy policies.

## Diversity Indices

This method takes a simpler approach in an attempt to measure security of energy supply. It is built on the theory of Stirling's[40] regarding diversity which is developed on the basis that scholars and policy makers are confronted by 'blind spots' due to the uncertainty of the future[41]. This could then result in inaccurate measures regarding security of energy supply. Therefore the best way to be able to deal with security of supply is through diversifying suppliers and energy sources; the amount of diversification can be measured by using the various diversity indices elaborated on below. A low value for the indicator is indicative of a weak security of energy supply, or having one source of energy.

There are four diversity indicators which build upon the basic indicator which measures;
*Diversification of energy sources in energy supply($I_1$)*

$$I_1 = -\sum_i (c_i^1 \, p_i ln p_i)$$

*$p_i$ = share of primary energy source i in total primary energy supply*
*i = 1...M: primary energy source index (M sources are distinguished).*
*$c_i^1$ = correction factor to $p_i$ for indicator $I_1$. All these correction factors are equal to unity in case of the first indicator.*

**Equation 1.3 - Basic Diversity Index**
***Source: Jansen et al. (2004)***

This basic indicator takes the diversity of the various sources of primary energy sources whilst assuming complete ignorance to all other factors. However the indices gradually build up by modifying the correction factor to account for various aspects that can influence diversity.

[39] Hughes & Shupe (2010)
[40] Stirling (2011) *The Diversification Dimension of Energy Security*
[41] Jansen et al. (2004) *Designing Indicators of Long-term Energy Supply Security*

*Allowance for energy import dependency ($I_2$)* is the second indicator which accounts for net import dependency into to the index.

*Allowance for import dependency and long term political stability ($I_3$).* This adjustment ignores the political stability in the demanding country focusing only on the energy exporting countries. To account for political stability the authors use the UNDP Human Development Index (HDI)[42], which assumes that a high level of HDI is correlated with political stability.

The last of the diversity indicators created is with *Allowance for Resource Depletion ($I_4$)*. By accounting for the resource depletion in both the exporting countries as well as in the home country the index looks to account for the fact that energy resources are generally not renewable.

All four diversity indices seem to provide replicable results. This is mainly due to the fact that quantitative data is the primary source of information in the creation of the various indices. Even when the correction factor is modified for the $I_2$-$I_4$, the modifications are based on quantitative variables using strong data.

The indices are very transparent and understandable. It is clear how and what each index accounts for and attempts to communicate. By using a base indicator and adding various effects through each subsequent measure, they show how each aspect affects the diversity index. Added that the correction factor is defined with quantitative variables allows for transparency in the design of the different indices.

The biggest problem with the indicator lies with its justifiability. It seems understandable to make the assumption regarding the existence of 'blind spots' but it seems a little bit of a simplistic assumption to make that the only way to ensure security of energy supply is through diversification. However if one were to agree with this assumption the measure itself is very well designed to measure diversification. The modified versions of the indicator relax the assumptions regarding blind spots and include certain variables. Furthermore with regard to political matters the model assumes that a high HDI would be a result of high levels of political stability. This may be a simplistic assumption to make and may not be the best measure to take into consideration political stability.

The focus of the various diversity indices is regarding **accessibility** via diversifying primary energy sources and suppliers. Through $I_2$ the accessibility is enhanced while availability can also be accounted for. $I_3$ attempts to include geo-political aspects but at a very simplistic level, however this again just enhances the ability of the measure to account for accessibility. $I_4$ enhances the ability of the measure regarding availability by accounting for resource depletion. Therefore it can be seen that this measure fails to account for affordability and acceptability. In terms of its usefulness, this measure is very good at measuring the level of diversity in the energy supply and is one useful tool in dealing with a particular aspect of security of energy supply. It creates an inventory regarding demand and benchmark to which policies can be evaluated against.

[42] HDI consists of four indicators – life expectancy at birth, mean years of schooling, expected years of schooling and gross national income per capita

## ECN Standards – The Supply/Demand index

The Energy research Centre of the Netherlands (ECN) has presented a paper[43] that brings about three aspects regarding security of energy supply. Two of these are quantitative indicators in the form of an index. The Crisis Capability (CC) Index represents short terms considerations and the Supply/Demand (S/D) Index a medium to long term perspective. The final and equally important aspect is a qualitative study regarding multilateral actions, which calls for policies to be made in terms of the possible actions a jurisdiction might take part in at an international level.

### *Crisis Capability (CC) Index*

This measure takes a short term perspective for the ability of a country to be able to mitigate an energy supply security crisis. The index can be seen as being comprised of two separate assessments; a risk assessment and a mitigation assessment which, when combined, provide a Crisis Capability Index. Neither the equation nor the elements included will be dealt with further here due to the fact that the CC Index addresses short term considerations.

### *Supply/Demand Index (S/D Index)*

The Supply/Demand Index (S/D Index) was developed to allow for a review and assessment of energy security of supply in the medium and longer term. For these reasons the scholars develop the boundaries of the energy system to include; final energy demand, energy conversion and transport and primary energy supply.

The S/D Index Model uses four types of inputs:

1. *shares* of different types of supply and demand, these can be seen as the categories for the different branches in the diagram below.
2. *values*, characterizing capacity and reliability,
3. *weights,* determining the relative contribution of different branches of the model, depicted by the values given to each branch in the diagram below.
4. *scoring rules,* determining the index value of each individual aspect contributing to the S/D index.

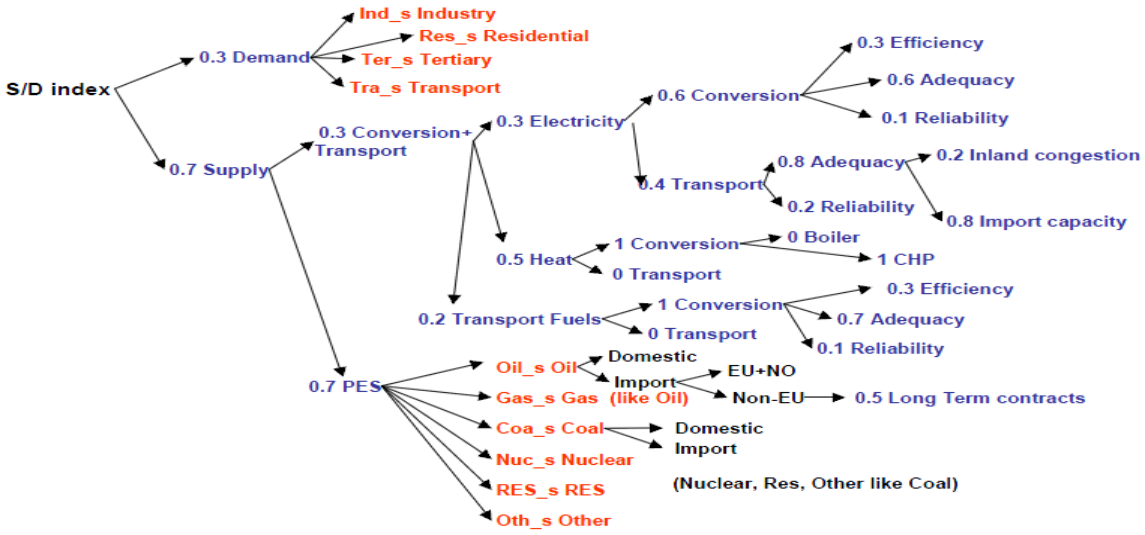


**Figure 1.3 – S/D Index, Weighting and Scores**
***Source: Scheepers et al. (2007)***

[43] Scheepers et al. (2007) *EU Standards for Energy Security of Supply*

It should be noted that the first two inputs are objective while the weights and scoring is done subjectively, the higher the vulnerability the greater the weight. Further as depicted in Figure 1.3, blue text indicates subjective weighting whilst red indicates objective weighting. This is done by looking at the share of the relevant input. The makeup of the various branches can be modified as to the nature of the country to be studied, however the ECN used these for their study of the EU as a whole, with the following weighting based on expert opinions.

Unlike many other measures the S/D Index attempts to include the relationship of demand side forces on energy security. This is done by adding the energy intensities of the various sectors. Furthermore the scholars mention that to create the final value for the demand index a benchmark must be created using the performance of the five best performing member nations for each sector. The ratio of the benchmark and the performance of a member state/EU is created, weighing this by the ratio between the share of each demand sector and total final energy demand. This concept has been simplified according to the scholars themselves to try and maintain simplicity and transparency.

The results of the S/D Index suffer in terms of replicability. The issue lies with the weighting being subjective in nature where quantitative data cannot be used. Secondly some of the scoring rules are subjective in the way which they are designed. An example of a scoring rule would be "Nuclear energy will have a value of 100 irrespective of the supply origin because supply risks for uranium are relatively low."[44] Throughout the study there are more scoring rules like this, where justification has been given but the subjective nature of these rules ensure that if given to a different group of scholars the results may differ due to different rules being developed, is such flexibility is allowed.

The transparency was a large goal for this study and it was explicitly stated that complex calculations were avoided to ensure higher levels of transparency. This has been achieved in the sense that it is quite simple regarding how scores are given. That did however increase the subjectivity of the results through the weightings and the scoring rules. Saying this, the results are clearly understandable and since each branch is given a score, it is clear how improvements to various aspects of the energy systems security can influence the final score.

The justifiability in the way the index is set up is high, but it suffers regarding each individual scoring rule. As this could be a basis for an entire paper on its own this thesis will not go into the details regarding each scoring rule, it will point out that this is probably where the S/D Index could possibly come under the largest amount of scrutiny.

### *Multilateral Actions*

The scholars who created the S/D Index realized the importance of multilateral actions and the role they play in security of supply. Therefore it is stated that countries as a base of a study should develop a policy document where energy diplomacy between producer/consumer relations are discussed. There must be a difference between the willingness and its capability to participate or in certain actions. Although this acknowledges geo-politics it does not account for either the influence of international relations theory or the effect of a policy maker's perception on the way that threats are perceived. It also does not consider the way that the measurements themselves can be influenced in terms of the design.

[44] Scheepers et.al (2007, p. 34)

The aspect of multilateral actions within the ECN standard will not be discussed in further detail. It is firstly not quantitative, and although it attempts to account for the influence of multilateral relationships, it does not use international relations theory to provide a basis for the actions or choices that nations would make in such a policy document.

### *The ECN Standards Combined – SoS Index*

Thus although these documents are to be reviewed when determining energy security they do not feature overall in the quantified value for security of supply (SoS) index, which is a combination of the S/D Index and the CC Index.

$$SoS\ Index\ =\ {}^{2}/_{3}\ S/D\ Index\ +\ {}^{1}/_{3}\ CC\ Index$$

**Equation 1.4 - Security of Supply - S/D Index and CC Index combined**
***Source: Scheepers et al. (2007)***

The weighting for the two indices can change however, ECN deems the importance of long term energy balances as higher than short term supply shortages and therefore provides a higher weighting. The higher the score on the SoS index the greater the level of energy security.

The measures combined focus on **accessibility** but to say it does not account for the other A's would be incorrect. It includes availability through the measuring of energy sources domestic and imported. Affordability and acceptability can be seen as influences on energy demand and thus accounted for. It is important to point out that the S/D Index is one of the few indicators presently which account for demand side influences on security of energy supply.

## Concluding remarks on 'Identifying vulnerabilities'

Recalling the energy spectrum, one can now view where simple and aggregated, fall as presented in figure 1.4 below.

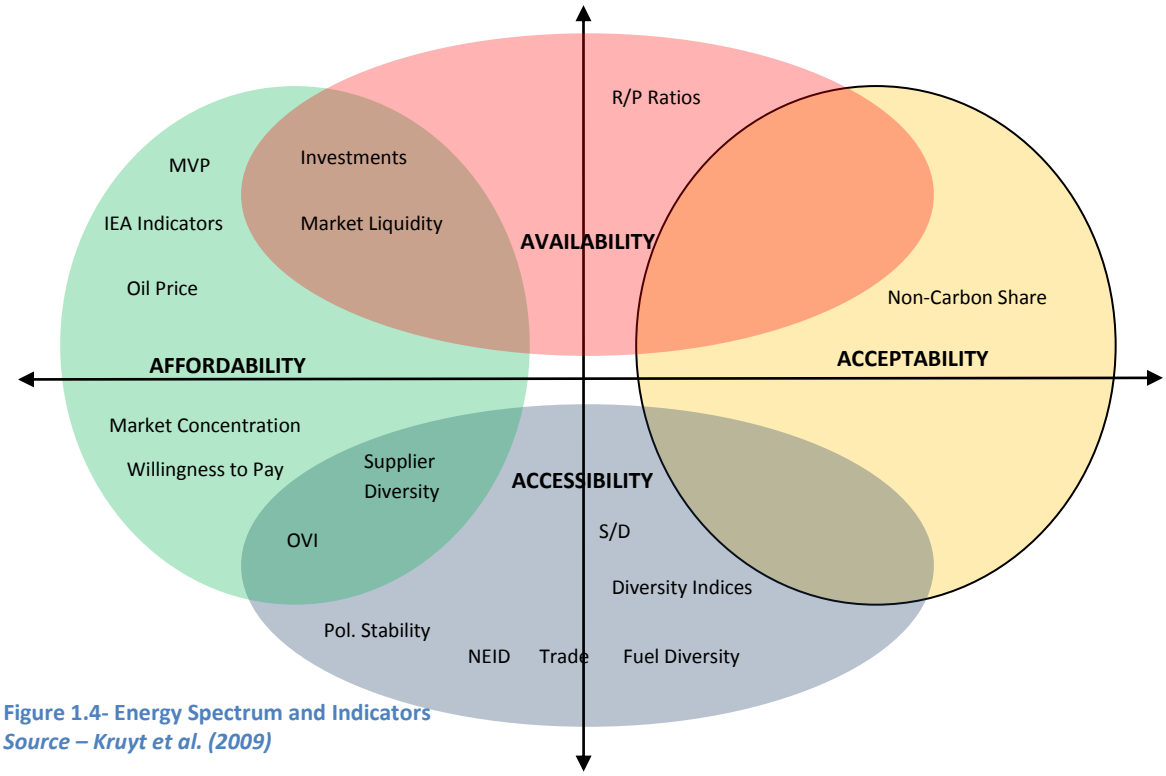


**Figure 1.4- Energy Spectrum and Indicators**
***Source – Kruyt et al. (2009)***

It is however wrong to say that if an indicator falls in less than one A it does not include another. The purpose of such a diagram is to illustrate what aspect of energy security a particular measure emphasizes. For example the S/D index does take into consideration availability, however that is not the focus of the measure; rather it attempts to determine security in terms of accessibility. Another comment to make about the measures is that in regards to the ability of the measures to capture various aspects of international relation theory or geo-political elements. There is no measure which does it in an adequate quantitative manner. This is not to say that the various scholars have not considered these aspects, however to be able to quantify these is extremely difficult as they are very subjective and tied to the various political regimes in a country.

When the measures do attempt to address the issue it is also always an external perspective that is approached. The question is how the energy exporting countries behave or what condition they are in. There is little analysis of the internal aspects of a country and what is driving demand for various sources of energy or how an importing country views itself in relation to exporting countries. Only within the S/D index do they call for the policy statement regarding multilateral actions.

Thus these indicators and measures are present to identify vulnerabilities and threats as well as providing inventories of existing policies and demand to be able to benchmark and see the effects of changes in energy policy. They provide a way of understanding the threats and vulnerabilities but do not address the perception of threats. Although objective in nature these quantitative indicators do possess aspects in their design that are subjective and moreover results can be interpreted differently. This paper points out that it is international relations theory that influences the subjective aspects of quantitative indicators in the way actors perceive their position and the perception of the system with in which they interact. Therefore Part II will focus on identifying actors and worldviews in order to gain a deeper understanding of the complexity that characterizes security of energy supply.

# II. IDENTIFYING ACTORS
## – QUALITATIVE THEORIES OF INTERNATIONAL RELATIONS

Understanding energy security is in many ways the same as understanding the perceptions of threats and vulnerabilities. Part I above, dealt with quantitative indicators when measuring energy security. Part II will instead focus on the subjective aspects, dealing with the *perception* of the actor's position (the internal dimension) as well as on the system in which they interact (the external dimension). This part provides important insight in the often implicit choices and opinions that affects the decision makers and policies.

Using two well-established approaches in the literature, the next part is a starting point to the discussion on how international relations influence the security of energy supply. By focusing on three major themes – *the system and the actors*, *cooperation*, and *security* – the chapter is an attempt to identify important distinctions and divergences that could influence decision makers' perceptions of threats, vulnerabilities and security. However, instead of going back to the historical roots of each theory, this section starts off with a brief overview on the second generation scholars (i.e. Waltz, Nye and Keohane).[45] Emphasis is placed on how these theories on international security can be elaborated on in order to be more applicable to the energy issue.

## Structural Realism

Often seen as the prominent figure in structural realism, Kenneth Waltz[46] saw a need to provide a more predictive theory on the actions of states. In contrast with its historical roots of *realpolitik*[47], which can be seen as an inductive theory which analyzes existing conflicts or interactions between states, the theory of structural realism argues that the playing field is very limited.

### *The system and the actors*

The actor in focus in this theory is the *state* and the state alone. Multinational corporations, institutions and international agreements are acknowledged but are seen as means or tools for the powerful states rather than actors in themselves. The reason for this is the structure and the ordering principle of the international system, which is *anarchic*. This implies that there is no higher unit than the sovereign state in the system. No world government or supranational court can come to a nations rescue when things go wrong.

Therefore, an important element in structural realism is the *distribution of capabilities*.[48] In the absence of a worldwide government, the only way towards security is through the allocation of power. However, in contrast to former realist, power is no longer seen primarily in terms of military, or hard, power. In structural realism, due to the anarchic structure of international affairs, states' actions are based on their sizes, economic means, leadership qualities and whatever gives them a unique position in the system. As the oil crises showed in the early 1970's, energy could very well be seen as an important mean of power.

[45] For a comprehensive work on each of the theories see e.g. Dunne & Schmidt (2008) *Realism* and Dunne (2008) *Liberalism.*
[46] See e.g. Waltz (1979) *Theory of International Politics*; (2000) *Structural Realism After The Cold War*
[47] See e.g. Morgenthau (1955) *Politics Among Nations: The Struggle for Power and Peace*
[48] Lamy (2008) *Contemporary Mainstream Approaches: Neo-realism and Neo-liberalism*

### *Cooperation*

One important aspect in international relations is that of gains, and whether an actor should focus on *relative* or *absolute* gains. According to structural realists, as a way of pursuing power and to strengthening ones position in the anarchic world, actors compete and engage in cooperation only if there are relative gains to obtain. As being a predictive theory which aims at explaining states behavior, structural realists argue that the likelihood of states abandoning international cooperative efforts increases if the participants see other states gaining more from arrangements, than themselves.[49]

In a world of uncertainty and competition the fundamental question for structural realists is about *survival*. There are no institutions, norms or laws that cannot be cheated on and the promotion of sovereignty and self-help is therefore a crucial part in states' quest for survival. Institutions and binding agreements are therefore considered reducible to being tools for the powerful in controlling the other actors. In turn, what I gain from an agreement is only one aspect, as important is what you gain from it – and how my share stands in relation to yours.

A distinction is often made at this point between 'offensive' and 'defensive' realism. Kenneth Waltz can be seen as the promoter of the latter where the primary concern of the states is "to *maintain* their positions in the system."[50] This can easily be contrasted by the offensive approach suggested by scholars such as John Mearsheimer who argues that "states seek to survive under anarchy by maximizing their power relative to others"[51] as well as in Fareed Zakaria when he argues that "the best solution to the perennial problem of the uncertainty of international life is for a state to increase its control over that environment through the *persistent expansion* of its political interests abroad."[52]

When dealing with finite and rivalry resources (as with many sources of energy) there is a clear risk that the strategy chosen by actors falls under the 'offensive' category. As the oil reserves decline, the need for controlling these increases as long as a nation do not successfully decreases their dependence.

### *Security*

The most common approach towards maintaining security on the international arena has been through the *balance of power*. The creations of alliances during both World War I and II were mainly to withhold the status quo and to avoid any one actor becoming too powerful. With the end of the cold war, and the dissolvent of the Soviet Union, the world turned from a bipolar world to become more fragmented, moving towards multipolarity. Maintaining ones position in the international system then, required power. It is argued that in an anarchic system, where states seek to perpetuate themselves, alliances will be established in order to balance the power of threatening states.[53] These alliances are made through politically driven strategic actions and bilateral agreements. However, since the structure promotes self-help, where no other actor could guarantee a nation's survival, decision makers must be aware and remain cautious of the need to provide for their own national security as a last resort. This implies that the risk of cheating is always evident in

[49] Lamy (2008)
[50] Waltz (1979, p. 126)
[51] Mearsheimer (1994, p. 82. our italics) *The False Promise of International Institutions*
[52] Zakaria (1998, p. 20 our italics) *From Wealth to Power: The Unusual Origins of America's World Role*
[53] Waltz (1979)

any agreement. Referred to as a 'security dilemma', the intentions of the others and the misbelief thereof, often impedes long-term cooperation and rather increases the risk of an actor making a pre-emptive strike towards the other in order to get the highest relative gain possible. Before concretizing this into the case of energy and security of supply we shall shortly introduce a second approach to international relations.

## Liberal Institutionalism

Following the long tradition of Kant and Rousseau, liberals are arguing for a perpetual peace – a world where wars are unnatural and irrational. With a deep faith in human reason, wars are seen as a product of an upper 'warrior class' contrived to preserve the power of princes, statesmen and soldiers in order to "bind their tyranny even more firmly upon the necks of the people."[54]

Liberalism has since then developed, especially in the light of increased globalization. A key concept in liberal institutionalism is therefore *interdependence*, which refers to a complex process where transnational integration has increased to that extent that the welfare in country A deeply relates to the development of country B and vice versa. The prominent figures in liberal institutionalism are Joseph Nye and Robert Keohane,[55] who claim that the complex interdependence has four important characteristics: increasing linkages between state and *non-state* actors; a new agenda with no distinction between low (domestic) and high (foreign) politics; multiple channels for interaction among and across transnational actors; a decline in efficacy of military force as a tool for statecraft.[56]

### *The System and the actors*

There are similarities between the structural realism above, and the liberal institutionalism discussed here. Most importantly, they both acknowledge the anarchic structure of the international system. But even though the state is a key actor, within the realm of liberal institutionalism, states can choose to give up some of their sovereignty in exchange for security and cooperation. Hence, conflict is not a natural state in the international system, but rather an exception in cases of irrationality.

Liberal institutionalism therefore emphasizes non-state actors (e.g. multinational corporations or international organizations) when they argue that the anarchic system can be mitigated through institutions. These are in turn defined as "sets of rules which govern state behavior in specific policy areas"[57].

### *Cooperation*

Even if the idea of structural realism holds, that the world is in fact a highly competitive environment and that states are rational actors always seeking to maximize their interests, this does not necessarily lead to conflict. The reason for this, according to liberal institutionalism, is the complex interdependency which promotes cooperative multilateralism rather than conflict as well as absolute gains rather than relative gains. Cooperation is most likely to occur in areas with mutual interests and benefits, such as rules for free trade. This strengthens the idea that international relations need not to be a zero-sum game where someone's gain is perceived as another's loss.

[54] Howard (2008 p. 23) *War and the Liberal Conscience*
[55] See e.g. Keohane & Nye (1972) *Transnational Relations and World Politics*;(1977) *Power and Interdependence*
[56] Lamy (2008)
[57] Burchill (2005, p. 64) *Liberalism*

Even if the neo-liberal era that followed after the 1970's have made some scholars to question the importance of the state altogether, and even stating that the breakthrough of liberal ideas have led to "the end of history"[58], the debate is still far from over. The response from structural realists have been the introduction of the concept 'asymmetrical interdependence', arguing that trade and other agreements are only means for the powerful.[59] Hence, relative gains still exist and cooperation is overvalued as a way of addressing conflicts in the international system.

### *Security*

The idea of achieving stability through institutions can be found in Keohane and Martin: "institutions can provide information, reduce transaction costs, make commitments more credible, establish focal points for coordination, and, in general, facilitate the operation of reciprocity." [60] As an example they point to the importance of political and economic institutions in overcoming traditional hostility in European states as well as the establishment of NATO.

One major breakthrough for liberal institutionalism in general, and the idea of a complex interdependency in particular, came with the oil crisis in 1973. There was a lack of predictive capabilities in the theory of realism and the faith in military power, since it was unable to explain why countries with a much greater capability did not take measures on the OPEC-countries. However, with a more integrated economic system, came new challenges for institutionalists and embracers of free trade – the risk of market failures. For some scholars this acts as an important justification for state action, and calls for intervention in particular markets in order to ensure welfare and security of citizens.[61] A common approach towards this within the liberal institutionalism has been the idea of a 'public policy', which should address four key issues.

First, it should deal with imperfect competition and market imbalances caused by cartels. The oil crises were a result of the responses from oil exporting countries to the demand-side cartel of the Seven Sisters[62]. These countries then established the OPEC, which in turn was balanced by the creation of the International Energy Agency (IEA). A second task for a public policy would be to deal with insufficient information, through market transparency and planning. As an example, scholars often mention the official reporting of output levels from exporting countries such as Saudi Arabia, while data from key consumer nations like China tend to lack accuracy.[63] To reduce negative spillover effects and externalities in terms of price volatility is a third issue addressed in a public policy. Lastly, to overcome the free-rider problem, and to create mechanisms for burden sharing is crucial in a public policy. This would include consumer-nations to co-finance maintenance of unused spare capacity, finding a collective mandate to secure crucial transport routes and to accommodate new heavy consuming countries such as China and India into the IEA framework in order to buffer sudden supply shocks on the market.[64]

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[58] Fukuyama (1992) *The End of History and The Last Man*
[59] Waltz (2000)
[60] Keohane & Martin (1995, p. 233) *The Promise of Institutionalist Theory*
[61] Bator (1985) *The Anatomy of Market Failure*
[62] The seven were: Standard Oil of New Jersey, Standard Oil of New York (Exxon Mobil), Standard Oil of California, Gulf Oil, Texaco (Chevron), Royal Dutch Shell, Anglo-Persian Oil Company (BP) and in 1973 the Seven Sisters controlled for 85% of world's oil reserves.
[63] Goldthau (2011)
[64] Goldthau (2011)

Even though this would make the dynamics of energy security a lot more complex than in models where energy is a weapon in the struggle for power and states are sovereign black boxes, it would allow decision makers to develop much more sophisticated policy tools rather than getting stuck in pure geopolitical rhetoric. In the next part to come, the ideas of a market driven or political-strategic approach towards energy security will be elaborated. The argument being posed is that how you address these issues is by and large a result of your perception of the international system, and your place within it.

## Elaborations on International Relations in respect to Energy

Based on the two general theories of international relations above, attempts have been made by several scholars to outline approaches or frameworks for policymakers when dealing with energy security. A recent one is the idea of certain 'futuristic mindsets'[65] where a given set of options are presented in order to predict the behavior of decision makers in their attempts to cope with uncertainties. However, this approach will not be elaborated on further since it does not have a great explanatory power in how the world itself could turn, but rather focuses on the individual decision makers.

One of the more comprehensive attempts to incorporate international relations is provided by CIEP.[66] Deriving from the structural realism on one hand, the authors present an approach they call *Regions & Empires*. On the other hand, they elaborate on the liberal institutionalism in their approach *Markets & Institutions*. Used as scenarios or predictions of the future, these two storylines give important insight in what policy tools are effective, or even available, for decision-makers. Furthermore, internal as well as external dimensions in international politics are emphasized, such as the development in exporting countries and the possibilities for cooperation within the importing ones. It should also be stressed that the framework of the four A's presented in the beginning helps in making the distinctions between the two approaches clear. This is especially true when discussing accessibility which is interpreted very differently depending on the worldview taken.

### Regions and Empires

Building on the ideas of Kenneth Waltz, the *Regions and Empires* (RE) storyline points to the fact that no world government exists to insure a nation's survival in a competitive environment. Instead, the world consists of either alliances with inter-block interests (regions) or sole states with great powers (empires). Therefore the RE storyline sees energy security as being dealt with through a highly political-strategic response where the state takes a coordinating and intervening role to ensure relative gains and a maintained (or expanded) position in the system. This is because the competition for scarce resources between the *consuming* countries encourages, rather than alleviates conflict. Thus, the level of distrust among nations is large. This follows the tradition of structural realism and further acknowledges the difficulties for international institutions to mitigate the competitive and conflict-driven politics. As a result, the goal of securing vital energy supplies will be driven by

[65] Cherp & Jewell (2011)
[66] van der Linde et al. (2004)

strategic bilateral agreements and long-term contracts"[67] which in turn will override arguments of market efficiency.

Markets will still exist, and remain important in some areas such as the production of manufacturing goods, but national security is still the primary task for decision makers and in that quest energy will be dealt with through controlled relationships and treaties. The international institutions, such as the UN, WTO, IMF or even EU, will become very weak as they will lack legitimacy due to powerful countries refusal to participate. As a result thereof, environmental concerns are not a prioritized area. Instead, short termism, local political instability and advocates of NIMBY (not-in-my-backyard) could become ever more evident. Physical control over important geographical areas and the resources therein, is also more likely to be part of the consuming countries strategies. In a worst case scenario this would lead to preventive strikes in order to get a first-mover advantage (resulting in the important relative gains).

The fact that stronger states (empires) maintain a great military capability has led to the question whether or not they act "hidden behind the veil of a market-oriented approach."[68] Most consumer states today favor the present system with free trade, but indicators point to the fact that for example the U.S approach has shifted from multilateralism to a strategic bi- or even unilateral system that serves the national, rather than the international and global economic system. Some examples of the rejections of international institutions, providing evidence of a RE-approach is found in the refusal to ratify the Kyoto protocol, actions taken in Iraq without global consent from e.g. UN and bilateral agreements with heavy oil exporters such as Saudi Arabia. Furthermore, as the impact of China on the world market increases, a country whose government takes a highly strategic approach, there is a risk that the energy trade flows changes dramatically.

As a result of the focus on relative gains and harsh competition in the international system, little attention is given to the dimension of *acceptability*. The small acting space of states does not allow environmental considerations and social dimensions when discussing certain energy sources. Neither is the issue of *affordability* a big topic since the threat of military interventions in resource rich regions is seen as a better insurance against welfare loss than the maintenance of markets. What is emphasized then is, on one hand, *availability* including the control of infrastructure and resource reserves, and on the other hand, *accessibility*. As seen in the quantitative indicators this latter aspect of energy security is hard to measure since it incorporates weighting and subjective interpretations. This is also the reason why accessibility is the only 'A' that is emphasized by both approaches. In the *Regions and Empires*, with its focus on state actors and power politics, access to resources are managed through bi-lateral agreements at most, and in some cases unilateral actions through invasion or threat of military force in order to secure energy flow.

### Markets and Institutions

The *Markets and Institutions* approach (MI) involves a continued social, cultural and economic integration of the world's countries and markets. This would imply that Russia, as well as Turkey, are integrated into the EU market and that multilateralism and further liberalization of markets allow the flow of goods and capital to grow. In turn, economic institutions such as WTO, IMF and IEA play an

[67] van der Linde et al. (2004, p. 118)
[68] van der Linde et al. (2004, p. 88)

important role as 'market forces', as the UN will be for mitigating international, as well as regional conflicts.

Most importantly, the international system is characterized by cooperation, both economic and social. Not only state actors but also NGO's and the civil society play a crucial role as environmental and equity issues will become embedded in the policy making. Generally, no bilateral contracts are concluded, but the energy resources are sold on an international market. An important part in this approach is the burden sharing where the "investment climate is adjusted to facilitate…important investments and the costs (tax breaks and subsidies if needed) are shared among producers and consumers."[69] Hence, the collective and absolute gains of cooperation is acknowledged and the interdependence both within as well as between importing and exporting countries is a driver in the international system.

This implies that overcoming the risk of 'market failures' discovered above is crucial. The establishment of transparent markets, where not only security of supply but also of demand will increase efficiency, as well as insuring that the price mechanism functions. As the level of trust within the system is significantly higher than in the RE-storyline, environmental agreements such as the Kyoto protocol serves as a fundament for the protection of public goods. With investments in new technology, national as well as abroad, rich and powerful countries can take a responsibility in addressing climate change.

It is easy to see the MI approach as a best-case scenario, and to even accuse it for being a bit too utopian. Many scholars however embrace the market solution and argue that there is no need to secure access to equity oil other than through the market. Rather, as argued by Marcel and Mitchel of the Royal Institute of International Affairs, the "crucial requisite for energy security is to get the oil on the market and to prevent any disruptions of supply. In terms of the energy security of importing states, it is irrelevant who sells the oil and who buys it."[70] This approach could easily be juxtaposed to the bi-lateral strategies undertaken by the U.S and increasingly by China in securing the world's oil reserves and shows in a clear manner the two distinct approaches towards energy security - a market driven solution or a political strategy.

In sum, the *Markets and Institutions* approach focuses less on the *availability* of resources as such, but rather on the flow of the goods on the market. Hence, in contrast to the RE approach, *affordability* is crucial in securing the intact welfare of a region. This implies that a functional market without supply disruptions is critical and a top priority for policy makers. Furthermore, *acceptability*, and the incorporations of environmental and social considerations is given much more space in a world characterized by co-operation and interdependence. Renewable energy is not only seen as a way out of import dependency but also as a way of coping with climate change. *Accessibility,* as mentioned, is the 'A' which both approaches touch upon. With its focus on absolute gains and institutional settings, the MI approach addresses the issue of access through multilateral agreements and market driven solutions.

[69] van der Linde et al. (2004, p. 98)
[70] Marcel & Mitchell (2003, p. 2)

## Concluding remarks on 'Identifying actors'

As with the quantitative measures presented in Part I, the four A's can be seen as a good starting point in addressing energy security. The purpose of this chapter, however, has been to broaden the scope of how security is perceived and even more important, how it can be achieved. The conclusion that can be drawn out of this part is that the energy policies most likely need be incorporated with foreign and security policies in order to accurately address the problems that characterize international energy flows. Whether you see the sovereign state as the sole actor in an anarchic system or if you believe in cooperation and interdependence will have a great impact in the selection of policy tools and their implications, as threats and risks are highly related to the perception of the international system and the geopolitical settings.[71] Furthermore, without the insight and at least some predictions regarding the actions of other players, policy making will be confined to what is easily quantified and measured according with approaches presented in Part I.

The following section aims at identifying proper policy tools for dealing with security of energy supply which will be done by integrating objective and subjective approaches. It will be shown how different worldviews and perceptions can influence not only the interpretation of the results that come out of the measures, but also how they influence the way in which the models are initially designed.

[71] For an illustrative summary of the theoretical framework presented in this part see Appendix B.

# III. IDENTIFYING POLICY TOOLS
## – INTEGRATING QUANTITATIVE AND QUALITATIVE APPROACHES

The aim of this study was to present policy tools for promoting security of energy supply by integrating quantitative and objective measurements with a more qualitative approach which acknowledges the subjective aspects of policy making. Part I described and evaluated quantitative indicators or measures for addressing security of energy supply, using the Four A's and criteria for a good measure as a framework. Part II identified how international relations theory in the form of two worldviews, *Regions and Empires* and *Market and Institutions*, influence how various actors can be perceived.

This section will identify the tools available for policy makers when addressing security of energy supply. Policy tools are identified according to their ability to address the four A's, whilst understanding that the choice of policy may be made for different reasons depending on a nations worldview.

Keeping in mind the securitization process this requires that the objective and subjective approaches towards addressing security of energy supply are integrated. This is to show the reader how theories of international relations can influence the way in which a quantitative indicator, which is meant to be objective, is interpreted or designed. The synthesis is important as even though quantitative indicators are designed to be objective, subjectivity is present in either the design or the interpretation of the results.

The EU policies regarding energy security will be evaluated as a practical example of possible contradictions and clashes that exist if policies are not designed in coordination with various organizations within an institution. Moreover it shows why policy makers need to have clear goals in order to design policy in a way which can avoid clashes and contradictions.

A detailed description linking the approach of world views' influence (*Regions and Empires* and the *Markets and Institutions*) on design considerations and interpretations and the policy tools to address individual indicators is described in the Appendix C. The following sections regarding measurements and policy tools are derived from the findings in this appendix. The reader is encouraged to view the tables as they guide the discussions below.

## The measurements – Design and Interpretations

In Part I various quantitative measures have been identified, claiming to objectively evaluating levels of energy security. These measures were evaluated using criteria that is applicable to any measure, if they are *justifiable*, *understandable* and lastly if the results can be *replicated*. In terms of being indicators for energy security these were evaluated as to how they address the four A's, availability, accessibility, affordability and acceptability.

In this section we will provide a brief synthesis of Part I and Part II, how international relations theory affects the design of the metric or the way in which it is interpreted. A more detailed table is provided in appendix C where information is provided regarding the design of the metric, the interpretation, policy tools and policy considerations. The measurements will be evaluated from the viewpoint of the *Regions and Empires* and the *Markets and Institutions* approach accordingly. This is done in order to show how each of the measurements correspond to the goals and assumptions that

go inherently in the two worldviews. In this way various aspects of the different indicators which leave space for subjective decision making, will be affected and that can in turn influence the results of the indicator. This could be through weighting or placing importance on certain variables in the metric whilst interpreting the results. This will obviously differ for each indicator and that is what is discussed.

The argument driven is that policy makers in every nation must be clear on their perspective and the goals they want to achieve with a specific policy.

### Oil Vulnerability Index

Firstly actors that adhere to the Regions and Empires worldview (from now referred to as RE actors) may have a problem with treating all OPEC nations as one supplier as bilateral agreements can be made regarding price even though supply is planned by member nations. The political risk variable using ICRG data can prove to be problematic when interpreting the final value of the measure. If it has a large influence on the vulnerability a nation a RE actor may choose to ignore it due to the fact that they are not concerned with variables that account for the political risk rating, whereas the opposite may be true for followers of the Market and Institutions approach (from now on referred to as MI actors). They may be more willing to improve the political risk in trading nations than RE actors, who would just like to create a strategic alliance regardless of the inner working of a country.

The metric provides a good benchmarking tool for both RE and MI followers as it allows for both absolute and relative gains to be quantified. Its ability to provide recommendations is only hampered by the complexity in the design of the metric.

### Willingness to Pay

Nations would be concerned with the way the exponents are designed as well as the regional scaling factor. If the scaling factor takes into consideration regional spending on reducing security of energy supply risks RE actors may be unhappy, taking their spending to benefit themselves and strategic allies only. Therefore the way the scaling factor is defined will depend on the approach of the scholar. The exponents will also have to be adjusted to take into consideration the ideology of the nations as that will affect the way the 'nature of the dependency' is perceived. The diversity strategies have different meanings depending on the nations world view. RE actors would likely be concerned with the supply portfolio as they deal with import dependency. Followers of MI may be interested in both the energy portfolio as well as the production factors.

For RE actors this metric may prove to be slightly more useful than for followers of MI in determining the effect of policies as the few variables that are included may be enough in the RE approach. MI actors would like to be able to have more reasons such as affordability and acceptability concerns to increase a willingness to pay. Therefore in terms of being able to provide an inventory of policies this metric is limited as its ability to act as a benchmark. It can provide information for determining absolute gains but relative gains may be hard to extract from this measure.

### Decision Matrix

The decision matrix, being a skeletal framework upon which scholars can create their own indices means that there is little interpretation that can be done of the index itself. Rather the approach of the nation being studied or the scholar will influence the weighting as well as the alternatives and the metrics used.

Depending on whether it is a RE or a MI actor the respective A's associated with each approach would perhaps be given a larger weighting. The metrics would also be designed (or use existing metrics) that reflect most comprehensively what the scholar or nation perceive to be the threats that need to be accounted for.

The matrix provides a very comprehensive inventory of vulnerabilities and shows where policy tools can be put in place to improve the security of energy supply. However its role in determining relative gains is difficult due to the fact that the design can vary so much between nations. For viewing absolute gains it can prove to be a very useful tool.

### Diversity Indices

The way diversity indices are defined means that there is little that changes depending on the ideology of an actor. However follower of RE may be more interested in the results of $I_1$, $I_2$, and $I_3$ than those of $I_4$, whereas the political risk is what may be very relevant to MI actors.

In terms of utilizing the tool, RE actors would see diversity as a major tool. However rather than trying to obtain as many sources of energy they would rather like to secure strategic allies with nations which provide the largest inputs into their PES. This means rather than finding new sources of energy (alternative fuels), if it not domestically produced, RE actors would accept having a few important suppliers of fuel, as long as they are friendly. MI actors are unconcerned who is selling energy as long as it is available on the market at market price, they may like the influence of international markets and institutions to be in place in the metric.

As a review of the effects of policies regarding diversity the metrics is very well adjusted, however limited to diversity as a means to achieve security of energy supply. Benchmarking is also possible as it allows for both absolute gains and relative gains to be observed.

### ECN Standards - Supply/Demand Index

The CC Index is not included in this analysis; although it provides valuable insight into the security of energy supply situation of a country, it is short term focused and therefore not influenced by international relations theory. The only influence of the two approaches may lay in the fact that RE actors would only look at national crisis capabilities, whilst MI actors may look to their multilateral relationships to also aid in a time of crisis.

Since the S/D Index is very complex in the scoring rules and the design of the weights, this is where an actor's approach MI or RE would have greatest influence. The scoring rules would have to be reviewed individually for each branch and seen whether the scholars see the rules as applicable to the nation that is being studied. The weights would also change, RE nations may place an even larger weighting on supply risks associated with PES and MI nations may decide to place a larger weight on the demand side. Also the weighting associated with trading partners (in the study EU trading partners were deemed less risky) would change according to whether an MI or RE approach is followed.

In terms of observing a high risk, what nations would think would obviously depend on the values at the end of each branch. However if broad generalization were made it would be assumed that RE actors would look solely at supply side risks in an attempt to improve the level of energy security. MI actors would look at all aspects but would place a great importance on demand management as well as how conversion and transport of energy could be improved.

If the index rules and weights are not modified it provides a very good benchmarking tool to observe both absolute and relative gains. It also provides a comprehensive indication of vulnerabilities and threats, RE actors may only be concerned that it does not include the effects of strategic allies as suppliers of primary energy sources.

## Choosing Policy Tools – Why International Relations matter

How you perceive the world – the possibilities of cooperation, the likelihood of conflict, the motives and goals of your counterparts – will affect your approach towards security. The quantitative indicators play their role in creating inventories, benchmarks and assessing vulnerabilities within the energy system, and as shown above these measurements are interlinked with the theories of international relations as well. As explained in Part II, the two approaches – Regions & Empires and Markets & Institutions – emphasize different aspects of the four A's and by juxtaposing these here, this part points to some of the differences in how policy tools can be used in order to reach energy security. Although there are a multitude of policy tools available to address security of energy supply, the ones identified below are in direct response to the vulnerabilities that are identified through the measurements included in this study.

### *Availability*

As showed earlier, the aspect of availability is emphasized by the followers of Regions & Empires. By taking physical control of reserves and important infrastructure, security is addressed through the concept of relative gains where energy is part of a bigger zero-sum game. In the scheme presented in the appendix C, this could have several policy implications. Most important is perhaps the control of so called ***strategic reserves*****.** This would lead to a competitive advantage in times of sudden supply shocks but could be seen as an offensive approach by other importing countries and could also undermine the function of the market.

Another approach to enhance the availability in terms of energy security is through ***domestic production***. This would obviously reduce import dependency, which is an important variable in all of the quantitative measurements elaborated on in this thesis. As security is seen through the scope of self-help and survival within the Regions & Empires approach, environmental considerations are given little attention. Deep-water drilling and extraction from oil sands[72] are therefore a viable way of promoting domestic production.

The same implications can be drawn from the objective of ***promoting alternative energy***. This would improve the outcome of the Diversity Index since the rationale behind the measurement is that diversification, of suppliers as well as of sources, leads to higher energy security. Hence, to have a broad mix of sources in your Total Primary Energy Supply (TPES) is a goal in itself, whether or not these sources come from renewables or from finite sources such as nuclear, oil, natural gas or coal.

### *Acceptability*

In contrast to the ignorance of acceptability in the Regions & Empires approach, both social as well as environmental considerations are acknowledged in Markets & Institutions. By emphasizing the interdependence that characterizes the globalized world, common goals as well as common threats

[72] These are techniques that often are accused for having a huge impact on the environment. See for example Kelly et al. (2010); Oil Spill Commission (2011).

must be dealt with in a more co-operative manner. A way of addressing this in terms of energy policies are through the ***promotion of renewable energy***. Looking at the Diversity Index once again, diversifying the sources that sum up a nation's TPES is a primary target. However, not all sources are acceptable in regards to climate change or local pollution. Hence, ***diversification***, although an important policy tool, must be dealt with wisely. Energy security as interpreted in this thesis, is constructed by *all* of the four A's, and allowing a trade-off in acceptability, in favor of diversification will not result in enhanced energy security when looking at the concept from a Markets & Institutions point of view.

### *Affordability*

All of the measurements used in this thesis deal with affordability on a national level (e.g. cost of oil in national income or consumption of energy per unit of GDP). This leaves the aspects of energy poverty on household level aside and therefore no policy tools addressing this can be derived out of the metrics. What can be found however is the use of ***demand management*** as an important policy tool for coping with the risk of supply and price shocks. This aspect of energy security is not likely to be acknowledged by followers of Regions & Empires, who ignore the market response on energy security and focus more on the availability as argued above.

Increasing GDP in a faster rate than energy consumption, mainly through the promotion of energy efficient industries, will have a positive effect on measurements that deal with energy intensity (e.g. Willingness to Pay). Therefore, policies on ***energy saving*** and ***energy sharing*** are crucial in increasing affordability on a national level. The latter policy requires integration, both in terms of physical infrastructure such as international grid systems, as well as economically such as energy markets and burden sharing (sometimes referred to as vertical and horizontal integration[73]). By engaging in multilateral cooperation (e.g. with transit countries of important pipelines) as well as bi-lateral agreements through ***foreign direct investments*** (e.g. jointly improving important infrastructure in the supplying countries), energy security is enhanced through interdependency.

### *Accessibility*

As argued earlier, this dimension of the four A's deals with the geopolitical aspects of energy security which makes it hard to measure quantitatively. Furthermore, this thesis argues that it is the only dimension that truly overlaps the two approaches presented in Part II. The reason for this is simply that geopolitics and theories of international relations are deeply intertwined. As a result, it is here that the most obvious distinctions between the responses to energy security are found and the interpretations of the concept are most extreme.

Needless to say at this point, the Markets & Institutions approach believes in ***multilateral integration*** for coping with energy security. All of the measurements attempt to find indicators on geopolitical aspects such as political stability (OVI), Human Development Index (Diversity Index) or multilateral action (S/D Index). As mentioned however there are more to wish for (especially in the Willingness to pay which almost entirely ignores the aspect), since geopolitics is not easy to quantify. This is why this thesis also incorporates a more subjective approach in terms of international relations.

Crucial within Markets & Institutions is to uphold functional markets in accordance with the idea of absolute gains and interdependency. As long as the resources flow on a free market the price

[73] van der Linde (2004)

mechanism is most likely to work and the risk of price shocks are mitigated. An important part of this is through the use of ***foreign policies*** (e.g. foreign aid) in order to ***promote political stability***.

This way of addressing accessibility stands in stark contrast with the exercise of more 'hard' power within the Regions & Empires approach. The regimes in the supplying countries are not concerned, and in some extreme cases corrupt regimes could actually be preferred prior to democratic and stable ones if it helps getting ***long-term contracts*** in place. Instead, within Regions & Empires bi-lateral agreements (by strong 'empires') and ***strategic alliances*** (where weaker nations create 'regions') are crucial for maintaining the balance of power in the world. Once again, this leads to a focus on ***relative gains*** and as a result, the likelihood of ***military interventions*** increases.

Where Markets & Institutions is strictly limited to the use of sanctions and peace-keeping interventions within the framework of the international institutions such as the U.N Security Council, the unilateral security policy of the Regions & Empires approach plays a much more important part. By emphasizing survival and self-help in the anarchic system, the capacity to intervene in key producer regions depends by and large in the strength of military forces or other 'means of power' as explained in the structural realism above.

The most obvious policy tool, acknowledged by both approaches and by all the measurements, is that of ***diversification***. The rationale behind this tool is simply to put as many eggs in as many baskets possible, in order to avoid supply shocks or extortion of supplying countries that are using energy as means of power[74]. For the Regions & Empires, long-term contracts that provide fix prices and mitigate supply disruptions are of great importance. Building unilateral agreements with as many suppliers as possible is therefore in accordance with the understanding that international institutions, such as IEA or the U.N. are incapable of maintaining a safe environment for free trade and survival in the anarchic system. Markets & Institutions in turn, have two options in when diversifying the suppliers; either they mitigate the risk of supply shocks by importing from stable institutions such as OPEC only, or they go for a 'pure' market approach where free trade for all countries could lead to lower prices and larger supplies.

However, diversification could have an even more important implication when being used as a policy tool for addressing energy security. It may not be that it only deals with diversifying among suppliers, but also on the actual energy resources themselves. This is one of the more important aspects to keep in mind when trying to address all of the four A's in one coherent policy, as will be clear in the next section, where possible trade-offs and important considerations are presented.

Now that an integrated approach has been described it is clear that it is important to acknowledge both subjective and objective information in order to have clear goals when creating policy. The following section will scrutinize the messages being sent out by the EU through their energy policies, focusing on tradeoffs and inconsistencies that occur due to vague goals and contradictory objectives.

[74] This is why oil is sometimes referred to as the 'energy weapon'. See e.g. Muller-Kraenner (2008) *Energy Security*; Yergin (2006) *Ensuring Energy Security*

## Policy considerations in a European Union perspective

Ever since the presentation of the EU Green Paper in 2006[75], the energy policies within the union have aimed at three main objectives: competitiveness, sustainability and security of supply. Since then, binding targets have been set among the member states to *reduce* greenhouse gas emissions by 20%, to *increase* the share of renewable sources in overall share of energy to 20% (10% in transport sector alone) and to *improve* energy efficiency by 20 % - until the year 2020[76].

One of the most important steps in this work has been the creation of the Internal Energy Market[77] which would "stimulate fair and competitive energy prices and energy savings, as well as higher investment."[78] The internal market is said to have implications on all of three major goals of the energy policies: on *competiveness* since it would cut costs for citizens and companies and simulate energy efficiency and investment; on *sustainability* through economic instruments such as emissions trading mechanisms and by stimulating innovations on renewable energy; on *security of supply* through solidarity between member states, inter-connection capacity and through promotion of diversity.[79]

There are several interesting aspects in this belief in the market solution. To begin with, following the contradictions between the A's discussed above, inconsistencies can be identified in how to address affordability and acceptability. If the market in fact will cut costs for citizens and companies, it seems as if that would negatively affect the willingness to conduct energy savings and decrease energy intensity. Furthermore, and more important in terms of international relations, it seems as if the policy only deals with the internal dimension of energy security. Energy sharing, a policy tool introduced above, could indeed have a positive influence on security of energy supply but is more a matter of energy distribution within the energy system, rather than the access to external energy resources.

Noteworthy here is that the implications of international relations theories on decision maker's way to address security are in many ways similar to the classic game of the Prisoner's dilemma; there is a clear risk of taking the shortest straw if player A chooses to co-operate while the counterpart uses the strategy to defect. Thus, multilateralism is a joint venture between securitizing and functional actors, making it a strategy that requires a consensus on the global arena in order to work. Some recent reports, however, tend to show that the strategies of the major powers in the world (e.g. U.S., Russia and China) are closely connected with a big military defense which would imply a struggle for power and over resources with a resemblance to structural realism rather than a high faith in markets and institutions (see figure 3.1 below).

[75] EU (2006) *A European Strategy for Sustainable, Competitive and Secure Energy*
[76] See for example EU (2007a) *Renewable Energy Road Map*; (2009) *On the Promotion of the Use of Energy from Renewable Sources*; (2011) *Energy 2020*
[77] See for example EU (2007b) *An Energy Policy for Europe*; (2011) *Energy 2020*
[78] EU (2007b, p. 4)
[79] EU (2007b, p. 6)


Figure 3.1. *Military Expenses in the World*

The modest number presented in the figure above, a four percent increase in military expenditures within the European Union, tends to indicate that the security strategy chosen emphasizes absolute gains, cooperation and institutional agreements instead of the use of brute force. In regards to security of energy supply in particular, scholars have pointed to the fact that EU has moved from a 'controlled integration' towards a market-driven integration where the formerly important role of governments as owners and managers have declined so that "international trade in energy would become subject to competitive market conditions."[80]

This strategy must be juxtaposed to the fact that the nationalization of natural resources has continued to increase. Hence, EU promotes a market driven approach in a global system which in fact is characterized by governmental intervention and ownership. A new World Bank report confirms this and argues that the role of National Oil Companies (NOC's) have been largely neglected since these in fact control approximately 90 percent of the world's oil reserves and 75 percent of production (similar numbers apply to gas), as well as many of the major oil and gas infrastructure systems.[81]

Hence, promoting a market solution and to follow the *Markets and Institutions* approach, when indicators point to the fact that the world is becoming more divided into blocks and characterized by bilateralism, is an unwise strategic action influenced by a belief in free trade and liberalization. If this is the case, follower of Regions & Empires will have an advantage as being a first-mover if it turns out that the energy market will be less integrated and more of a struggle for power between military strong 'empires' such as the U.S, China or Russia.

[80] van der Linde et al. (2004, p. 77)
[81] World Bank (2011, p. ix) *National Oil Companies and Value Creation*

The multilateral approach in the different EU energy policies is obvious where it is stated that the EU must develop "effective energy relations with all international partners, based on mutual trust, cooperation and interdependence."[82] This is a text-book example of the Markets & Institutions approach and is closely connected to the use of trade policies as a way of reaching security of supply. Furthermore, it is argued that bi-lateral agreements could also be a way of reaching predictability through long-term investments and that these must be made in respect to the existing WTO rules and principles. As this thesis argues, energy security is closely intertwined with EU foreign and security priorities which is confirmed in a newly released EU report where it is mentioned that good governance, respect for rule of law and foreign investments in energy-producing and transit countries are essential for the security within EU.[83]

However, some tendencies exist that focus has moved away from the supplying countries towards the other large-consuming countries in the world.[84] Import dependency is likely to politicize the energy relations between powerful countries (e.g. the G8), and as a response to this EU takes a cooperative approach in order to promote open and competitive global markets.[85]

## Concluding Remarks on 'Identifying Policy Tools'

The aim of this study has been to present policy tools for promoting security of energy supply by integrating quantitative and objective measurements with a more qualitative approach which acknowledges the subjective aspects of policy making. A comprehensive collection of the findings, regarding the influence of international relations theory on design, interpretations and policy is in Appendix C. The thesis used recent energy policies within the European Union as an example and attempted to pinpoint possible contradictions or inconsistencies between several desirable objectives as a result of a narrow understanding of security of energy supply. Also identified are policy tools that address security of energy supply and how nations could use these tools to be able to cope with certain vulnerabilities. These vulnerabilities were identified by the quantitative indicators that are identified and evaluated using the framework of the Four A's as well as the criteria for a well-designed indicator.

However the main contribution of this paper is to identify and elucidate on the influence of international relations theory, in the form of the world views, *Regions and Empires* and *Market and Institution*. The influence is twofold; *firstly* in the way quantitative indicators are designed and interpreted. This is most prevalent if there are choices regarding variables to use as well as in the weighting or scoring; *secondly*, to be able to mitigate the threats the policy tools available also depend on the world view. It has influence in the way the goals to diminish the threat are designed, the choice of the tools and the rationale behind the choices. Even if the same policy tool is applied for the same threat, i.e. diversification, the rationale and implementation of the policy may differ depending on the worldview of the nation.

The EU is a working example of where certain policies have different and often clashing goals. One could see the tradeoffs between acceptability and affordability in the push for renewable energy.

[82] EU (2007b, p. 18)
[83] EU (2011)
[84] EU (2011); (2007b)
[85] EU (2007b)

Also evident through the military expenditure the difference in world views between other major powers and the EU. Therefore the EU would have to review its policy of multilateral agreements as it is not only energy suppliers but energy demanding nations that influence the way in which energy flows occur. Future studies regarding security of energy supply within the EU would benefit from incorporating a more comprehensive policy review, including security, energy, environmental and foreign policy.

In conclusion, it can be stated that being able to quantify security of energy supply is a complicated and difficult task. To be able to account for subjective reasoning in quantitative studies is always problematic and open to criticism. This does not mean that studies should not continue in this direction, but scholars and policy makers need to be aware of all the various influences upon security of energy supply and the information that can really be extrapolated from the quantitative indicators in the current literature.

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# APPENDIX A.
# METHODOLOGICAL CONSIDERATIONS

This thesis is the result of a complex process. The initial purpose was to measure the level of energy security and the differences therein between the member states of the European Union. However, as the work began it was soon evident that the concept of energy security, or security of energy supply as it also refers to, was highly debated and not nearly as easy to grasp as first thought of. In order to operationalize energy security, there was a need for a comprehensive and accurate definition of the concept. Hence, early on in the process it was discovered that the thesis would have lacked a great deal of *validity* if attempts were made to quantitatively measure a phenomenon which could not be clearly operationalized into good indicators. This problem is referred to as a lack of "construct validity"[86] which could lead to the fact that the quantitative measurements, even though perfectly set up and having great internal validity, say nothing about the phenomenon it aims at. Recalling the story of the blind men and the elephant[87], without knowing what to look for the results you get can be interpreted as anything and consensus will never be reached on what actually sums up to the concept.

As a result, this thesis is a starting point in a deeper understanding of the concept of security of energy supply. In order to identify and contrast different approaches to energy security we have chosen to conduct a qualitative literature review and text analysis. This fact does not make reasoning on validity obsolete, rather on the contrary.

A common approach in text analysis is to conduct an analytical scheme in which certain excerpts of texts are placed in correlating categories.[88] In this thesis we have however chosen to avoid this approach since it tends to simplify the texts into black or white and easy-divided tracks. The advantage of that method is of course an easy handled material, but the complexity of a subject such as energy security does not easily get divided into clear categories. Instead, the method in this thesis is a *qualitative* text analysis where each source is evaluated and discussed in a heuristic manner. The most important implication in terms of validity is the responsibility that is put on the conductor of such a literature review. Thus, the level of transparency and well-argued reasoning of the analysis is crucial to avoid critique on being biased or hiding discrepant information.[89]

Another important part of the literature review is of course the sources themselves and the selection process of which are included and which are not. Limitations in time and space of the thesis have had its implications on the number of sources, but most importantly the rejection of certain sources has been an active process. All the measurements are interpreted from the original sources and juxtaposed by other authors in order to accurately identify strengths and weaknesses. This is done by reporting criticisms made by the scholars who created the measures themselves as well as other scholars reporting on these measures. The criticisms will mainly be based on the criteria that 'good indicators' are justifiable, reproducible and understandable (transparent).

[86] Creswell (2009, p.164) *Research Design*
[87] The Elephant and the Blind Men
[88] See e.g Esaisson et al. (2007, ch.11) *Metodpraktikan*
[89] Creswell (2009)

The theories of international relations are also derived from original sources, as well as discussed through the use of contradicting opinions in order to avoid bias and narrow presentations. The role of subjectivity becomes central in this part of the thesis. The theories are, per definition, subjective and are used to highlight how the same world can be perceived very differently depending on an actor's position *in*, as well as the interpretation *of*, the international system.

### The impact of the chosen method on the disposition

The most immediate outcome in the thesis by choosing a literature review as the main method is the unclear division between description, empirics and analysis that otherwise tends to outline a thesis. Instead, this work is done in a more symbiotic and heuristic manner where certain texts are interpreted and juxtaposed continuously. To withhold a certain level of validity in such a process the chapters are heavily referenced and aimed at being written in a clear, well-argued and transparent way.

#### *Delimitations*

Another important aspect of the impact on the disposition is the delimitations that have to be made in qualitative research. In our case this has led to a restriction in both the measurements elaborated on in Part I, as well as on the extension on theories included in Part II.

Although it would be informative to go through the working of each measure in detail, it would be repeating information already existing; therefore references are given of the source paper regarding the construction of each measure. To include the simple measures would also be important as many of the aggregated measures use these simple measures. However, due to limitations in space, these are only mentioned briefly throughout the thesis and once again the reader is forwarded to the references in case of further inquiries.

In the second part of the thesis, approaches within the field of international relations that deal with social aspects (e.g. social constructivism, cosmopolitanism, feminism) are excluded. The reason for this is that our approach toward security of energy supply does not include the social aspects explicitly. This becomes evident in terms of the 'affordability' aspect of the framework, where energy poverty is only mentioned but not elaborated on. The measurements, as well as the internationals relations theories are on a national level (e.g. GDP growth) and not on a household level.

Furthermore, the context in which the thesis works is on a European level with a focus on EU Energy policies. Due to the limits in both time and space, the thesis does not dig deeper into the complex settings in which the European Union acts. Instead, EU is without further discussion seen as one coherent actor even though it consists of twenty-seven unique member states.

The reason for this is twofold. First of all, it is *de facto* the common EU energy policies that are under scrutiny and not the individual states approach towards energy security. Secondly, the EU policies are only used as an illustrative example and are given little attention in the thesis as a whole.

A final note needs to be made on the time horizon in the thesis, since the discussions on security of energy supply are done from a *long-term* perspective. The policies within the European Union have a ten-year perspective (the year 2020) which goes in line with the time scope used in this thesis, which means that crisis management and sudden supply disruptions are not emphasized to the same extent as e.g. diversification and large societal changes.

## APPENDIX B.
## SUMMARY OF INTERNATIONAL RELATIONS

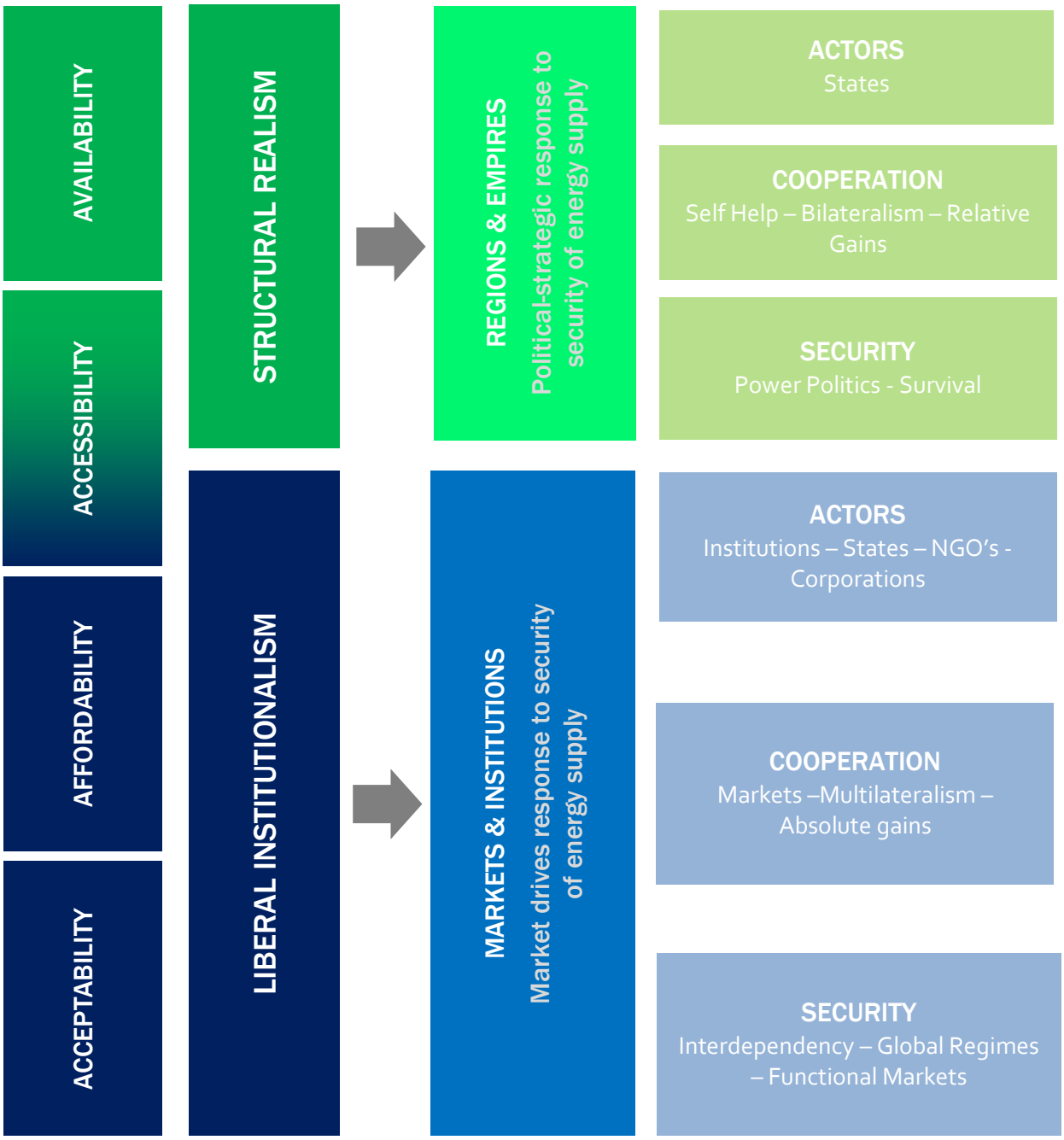


**Figure A.1** ***International Relations and Security of Supply***

# APPENDIX C.
# POLICY TABLES

| OVI | | | | |
|---|---|---|---|---|
| | **DESIGN CONSIDERATIONS** | **INTERPRETATIONS** | **POLICY TOOLS** | **POLICY CONSIDERATIONS** |
| **Regions and Empires** | Would like political risk to be modified perhaps to be able to acknowledge past cooperation between nations irrelevant of political stability. Could be achieved by taking voting patterns at the UN or other similar criteria.<br><br>To be able to account for bilateral relationships between nations.<br><br>May wish to treat OPEC as more than one supplier, supply is determined by OPEC but prices can vary between member nations.<br><br>Would like to maybe expand or weight supply risks greater then market risks. | A high level of vulnerability would cause concern amongst RE nations and policy makers would look how to improve the supply risks associated with oil vulnerability as a way to improve the value of the indicator.<br><br>It would be perceived that working on market risks would do little to enhance energy security so building relationships with diverse range of strategic suppliers would be the best way to secure oil.<br><br>May look to reduce the imports to consumption ratio, but if local supplies are exhausted it may do little to reduce demand locally if it is deemed to be for essential industries.<br><br>Provides good benchmarking tool to determine relative gains and provide vulnerabilities for policies to come into practice. | ***Availability***<br>**Promoting domestic oil production** / exploration<br>**Strategic Reserves**<br><br>***Accessibility***<br>In terms of the OVI improving GoR risks would not be a major concern. However **strategic alliances** and **diversification** would still be a goal to reduce the risk of concentrating sources of oil.<br>**Military intervention**<br>**Long Term Contracts.** | While promoting domestic oil production/exploration the main goal is to increase local supply, without taking environmental or social considerations into the decision making process (oil sands, Alaskan pipelines, deepwater drilling)<br>Strategic reserves serve as way with dealing with a supply crisis. This would ensure a buffer supply in case of a supply or price shock.<br><br>Strategic alliances can take various forms under the RE approach usually bilaterally and would be unperturbed by international agreements or international organizations stance on supplier nations. They would also be unconcerned with the political regime in power as long as long term contracts or supply can be guaranteed. Long term contracts often fix a price and mitigate risk of disruptions in supply. It could also encourage relative gains depending on the design of the contracts. The alliance may even be able to uphold a "bad" regime through military aid if it serves the purpose of reducing supply shocks in terms of oil.<br><br>Diversification of suppliers would be taken from a strategic politically point of view where suppliers are chosen to ensure relative power position. An exploitive approach is adopted, where suppliers are dependent on the buying nation through aid, military protection, threat of sanctions and unilateral actions. |

| OVI | | | | |
|---|---|---|---|---|
| | **DESIGN CONSIDERATIONS** | **INTERPRETATIONS** | **POLICY TOOLS** | **POLICY CONSIDERATIONS** |
| **Market and Institutions** | Ignores environmental concerns; may lead to an increase in vulnerability<br><br>GoR includes political risk in supplying country as only way of taking geo-political concerns into consideration.<br><br>Market risk should be made stronger as MI takes a market based approach, therefore geo-political effects on market power should also be considered.<br>Therefore may like market risks to be developed or provided with a larger weighting. | Indicates economy is vulnerable due to either supply risks, or market risks.<br>Following a MI approach more emphasis will be based on reducing the markets risks and would direct policy to affect those aspects of the measure.<br><br>Concern would exist in regards to the political risk variable. Would attempt to promote political stability in supplying nations.<br><br>Would use the measure to benchmark against oneself to ensure improvement rather than comparing with other nations.<br>Provides information regarding certain policies but not comprehensive enough. | ***Acceptability***<br>**Promote renewable**<br>Would result in reducing market risk as well as supply risk.<br>Reduces market risk via a reduction in oil intensity, cost of oil, and oil share.<br>Reduces Supply risk<br><br>***Affordability***<br>Is dealt with not at a consumer level, but at a national level. Therefore have to reduce the oil intensity and share, to reduce the market risks.<br>Can be achieved by **energy sharing and energy saving**.<br>**Multilateral integration to ensure burden sharing**.<br><br>***Accessibility***<br>**Diversification**<br>**Promote political stability** in supplying nations.<br>**Integration** through trade policy. Support international agreements and institutions (specifically dealing with supplying nations) | In terms of promoting renewable there would be a clear risk of contradictions between acceptability and affordability goals.<br>For example promoting renewable increases acceptability but could cost governments more in terms of infrastructure, R&D and labour costs. However it would reduce oil dependency and the share of oil in relation to the GDP.<br><br>Energy sharing between regional partners and energy saving at national level would also reduce the dependency on oil and reduce supply risks (crisis management).<br><br>Burden sharing ensures that costs of infrastructure can be shared by all those who can benefit (transit countries), as well as with energy sharing, ensuring cooperative approach towards energy security.<br><br>Diversification of suppliers (as this measure only deals with oil) could have two implications. Either to reduce risk of supply disruptions or to ensure as much oil is available, a “pure” market approach.<br>Reducing supply disruptions would involve importing from OPEC which set production levels for its members whereby countries can plan and ensure with relative certainty price levels.<br>If non-OPEC countries are engaged lower prices and larger supplies may be available but may entail larger risks in terms of price and supply volatility.<br><br>In terms of improving the OVI metric the main objective in terms of accessibility would be to reduce the political risk in supplying countries, or to not engage in trade with volatile nations<br>Integration and promoting political stability work in tandem and any actions have to take into consideration the concerns of international bodies. Integration economically or politically can be achieved but will need to be assessed on a case to case basis. |

| WILLINGNESS TO PAY | | | | |
|---|---|---|---|---|
| | **DESIGN CONSIDERATIONS** | **INTERPRETATIONS** | **POLICY TOOLS** | **POLICY CONSIDERATIONS** |
| **Regions and Empires** | Would not mind oil and gas as being the focus of the study if it forms the two largest components of PES.<br><br>Concerned as to the exclusion of geo-political factors. The effect of "friendly" trading partners may be included through exponents but it is unclear as to how objective values can be set. May use experts to decide what the value of these be and to reflect the attitude of the RE nations. | A high willingness to pay would indicate that action has to be taken in order to secure more suppliers, where the nature of the dependency can be considered low.<br><br>Would see reducing import dependency as a major objective.<br><br>Would use it as a benchmark against other nations to ensure relative gains.<br>Could view the measure as adequately measuring the effects of policies, but not providing an inventory to assess vulnerabilities. | ***Availability***<br>**Promote alternative fuels**<br>**Promoting domestic oil and gas production** / exploration<br>**Strategic Reserves**<br>**Diversification**<br><br>***Accessibility***<br>Though the measure does not directly include aspects of accessibility (geo-political elements), actions taken within this field can still influence the result of the Willingness to Pay measure.<br>**Foreign Policy**<br>**Military Intervention** | Promoting domestic oil and gas production can reduce the import dependency. This would be promoted irrelevant of environmental concerns, as long as import dependency can be reduced.<br><br>The promotions of alternative fuels would decrease the share of oil and gas in TPES.<br><br>Strategic reserves would reduce the need to import in a crisis situation or allow for buffer stocks.<br><br>Diversity would be addressed mainly through reducing import dependency rather than focusing on reducing energy dependency through gas and oil. Therefore they will look to diversify through the supply portfolio.<br><br>Accessibility was not addressed in the measure and there are problems with the exponents as explained in Part I. If they include geo-political aspects addressing supplier nations in foreign policy can improve the nature of the dependency and therefore influence the measure.<br><br>Military intervention results in a grey area in terms of how to view domestic production. Through physical control of a oil or gas source, a country could in theory value it as domestic production. In this case this would reduce the import ratio of the fuel, reducing the willingness to pay for avoiding security of energy supply risks. This could be accounted for through the values given to the exponents. It is also unclear whether to account for military expenditure in the regional scaling factor. |

| WILLINGNESS TO PAY | | | | |
|---|---|---|---|---|
| | **DESIGN CONSIDERATIONS** | **INTERPRETATIONS** | **POLICY TOOLS** | **POLICY CONSIDERATIONS** |
| **Market and Institutions** | Would like to be able to include other fuels that make up primary energy supply.<br><br>The fact that geo-political aspects such as multilateral relationships are not being included may be problematic. In line with that, when measures are taken to mitigate security of energy supply risks, how these investments at a multilateral level are included with national investments in the regional scaling factor is not clear.<br><br>The nature of the dependency (exponents) may reflect the MI point of view in the way the values are selected. However as this is done arbitrarily it is difficult to say how exactly it would affect the measure. | The high willingness to pay would indicate to a MI nation that not enough has been done to secure energy sources of oil and gas.<br><br>Entering into alternative fuels would only influence the value of the measure through the consumption ratio and may be a major part of improving the energy security but it would not be seen in this measure. Therefore MI countries may not use this measure heavily but could see a simple sense that either domestic sources need to be tapped or the energy intensity needs to be curtailed. However there is little information for an MI nation as multilateral relationships or the functioning of the market is not included.<br><br>The measure could prove to be a benchmarking tool but MI nations may not find it so suitable for their purposes due to design and justification of the metric. However in conjunction with other measures this may provide useful information to policy makers. | ***Acceptability***<br>**Diversification**<br><br>**Promote renewable**<br>Would result reducing import ratio of the fuel and share of fuel in TPES.<br><br>***Affordability***<br>Is dealt with not at a consumer level, but at a national level. Reduction of energy intensity through **energy saving** and **energy sharing.** Could also be done by **promoting energy efficient industries**. **Integration through burden sharing** of infrastructure projects would influence the scaling factor of the measure. Infrastructure can also be developed through **foreign direct investment.**<br><br>***Accessibility***<br>**Foreign Policy**<br>Support international agreements and institutions (specifically dealing with supplying nations). | The costs of renewable is not a consideration in the measure therefore to reduce the dependency of oil and gas promoting renewable is problematic in the way it influences the energy intensity overall through higher prices. It would also reduce the share of oil and gas in TPES.<br><br>Energy saving would reduce the energy intensity and energy sharing could reduce the risks associated with short term supply shocks. Promoting energy efficient industries would increase GDP at a faster rate than energy consumption.<br>Integration through burden sharing would result in the regional scaling factor being affected in the measure usually improving the value of the factor. The costs of projects / infrastructure which are aimed at reducing energy supply risks are accumulated and benefit all involved. This sharing can be achieved through foreign direct investment. This can also be seen as diversification resulting in reduction of energy dependency and dependency on gas and oil.<br><br>Accessibility was not addressed in the measure and there are problems with the exponents as explained in Part I. If they include geo-political aspects addressing supplier nations in foreign policy can improve the nature of the dependency and therefore influence the measure. |

| DECISION MATRIX | | | | |
|---|---|---|---|---|
| | **DESIGN CONSIDERATIONS** | **INTERPRETATIONS** | **POLICY TOOLS** | **POLICY CONSIDERATIONS** |
| **Regions and Empires** | The greatest influence of a RE approach on the design would be the way in which the weighting for the various criteria is adjusted. It would likely result in greater weighting applied to availability and accessibility.<br>In this context accessibility metrics would be designed to include strength of bilateral relations with suppliers as well as transit countries.<br><br>The nature of the matrix results that a lot of freedom is available for scholars to design metrics and establish criteria. Therefore the metrics chosen would represent a RE approach, aggregated or simple indicators can be used.<br>A study would probably consider oil and gas as having a larger weight or more importance in the overall index.<br>The importance of bilateral agreements and a way to establish "friendly" nations or strategic allies. This would be beside other simple indicators to provide references for diversity, reserve indicators, energy system flexibility etc. | Since all A's are included in the matrix as stated earlier policy makers would look to see how to improve availability and accessibility for each alternative that is established. It could be seen that affordability and/or acceptability can be completely neglected in the decision making process regarding policies.<br><br>This metric would provide policy makers a comprehensive review of the energy system in terms of the A's and provides benchmarking tools. However a drawback for RE countries is that it is difficult to compare the results of the decision matrix amongst other countries as the metrics and design would change for each country to be studied.<br><br>The comprehensiveness in being able to establish vulnerabilities depends on the design of the matrix. Benchmarking for absolute gains would be difficult. | Policy tools that will be developed from such a matrix will depend entirely on the design specifications. For an RE country as mentioned previously would focus on policies with regard to **availability** and **accessibility.**<br><br>The exact policies will depend on which metrics are chosen as that will depict what vulnerabilities need to be addressed. | Due to the lack of information on potential policy tools it is difficult to specify and considerations regarding policies. |

| DECISIONS MATRIX | | | | |
|---|---|---|---|---|
| | **DESIGN CONSIDERATIONS** | **INTERPRETATIONS** | **POLICY TOOLS** | **POLICY CONSIDERATIONS** |
| **Markets and Institutions** | The weighting will also be a consideration for nations following an MI approach. However here larger weighting may be places on accessibility, affordability and acceptability.<br>In this context accessibility would include the influence of international organizations, the functioning of energy markets both internal and international and aspects of multilateral relationships.<br><br>Again metrics would be chosen that can try and capture the point of view of a MI nation. That is why studies involving MI nations would include aspects such as including alternative energy sources. Also important would be risks regarding sudden changes in the energy market and the influence of international institutions on nations in general. | Since all A's are included in the matrix as stated earlier policy makers would look to see how to improve accessibility, affordability and acceptability for each alternative that is established. Availability would not be ignored, but it would be seen that little can be done to change the situation of availability due to most energy reserves being tapped (for developed countries).<br><br>This metric would provide policy makers a comprehensive review of the energy system in terms of the A's and provides benchmarking tools. For MI countries it provides a good tool for benchmarking their own performance in terms security of energy supply as they are looking to make absolute gains.<br><br>The comprehensiveness in being able to establish vulnerabilities depends on the design of the matrix. Benchmarking for absolute gains can be achieved. | Policy tools that will be developed from such a matrix will depend entirely on the design specifications. For an MI country as mentioned previously would focus on policies with regard to **acceptability, affordability** and **accessibility.** | Due to the lack of information on potential policy tools it is difficult to specify and considerations regarding policies. |

| DIVERSITY INDICES | | | | |
|---|---|---|---|---|
| | DESIGN CONSIDERATIONS | INTERPRETATIONS | POLICY TOOLS | POLICY CONSIDERATIONS |
| **Regions and Empires** | The simplistic nature in the design of the metric ensures that little design changes result with regards to world view.<br><br>However it could be seen that a RE country would have little concern for the political stability ($I_3$) but will focus heavily on the results of import dependency ($I_2$) and resource depletion ($I_4$). Using the HDI may be considered too simplistic a way to account for political stability in a RE approach.<br><br>They would probably like the effects of bilateral relationships to be included somehow in the measure, but as to the assumptions made regarding "blind spots" it is understandable why it is not included. | If the results of the metric are perceived to be low diversity depending on which form of the indicator is used the interpretation may change.<br><br>$I_1$: a low value would prompt RE countries to establish strategic alliances to be able to diversify their sources for particular fuels from "friendly," secure nations.<br><br>$I_2$: RE nations would be unconcerned by import dependency if it is deemed the countries forming a major part of their imports are strategic allies. If not they will try to either create a strategic partnership, or foster bilateral relationships to reduce the risks of supply shocks from exporting nations.<br><br>$I_3$: RE nations would not be considered about the political stability especially measured through the HDI. Therefore as long as the regime in power, whether practicing good governance or not, is secure there will be little concern.<br><br>$I_4$: Resource depletion would be a major concern for RE nations. This would prompt an analysis of their strategic partnerships and whether to continue with past alliances or foster new alliances.<br><br>Benchmarking for absolute gains is possible and vulnerabilities assessed. | ***Availability***<br>**Promoting alternative fuels**<br>Would influence energy import dependency and share of particular fuel in TPES.<br>***Accessibility***<br>In this quantitative measure accessibility is only accounted through long term political stability.<br>Due to political stability being measured through the HDI, improvements in political stability in supplier nations requires improvements in HDI. However a nation following the RE approach may choose to ignore this aspect of risk when calculating the Diversity Index.<br>**Diversification** of both suppliers and sources of energy. | The theory that this measure is developed on basically implies the only policy available reduce security of energy supply risks is diversification. This can be both for suppliers and the sources of fuels available. For the RE approach countries may not be concerned with the political stability in a nation as long as contracts are guaranteed but would be more concerned with resource depletion ($I_4$).<br><br>Since diversity could include all sources of fuel, discussions do not need to be limited to oil and gas alternative sources of fuel should also be considered i.e. biogas. However nuclear would be a viable option due to little concerns regarding acceptability. |

| DIVERSITY INDICES | | | | |
|---|---|---|---|---|
| | DESIGN CONSIDERATIONS | INTERPRETATIONS | POLICY TOOLS | POLICY CONSIDERATIONS |
| **Markets and Institutions** | Again due to the nature of the metric there is little that would change with regard to the design of the metric.<br><br>However it could be perceived that all of the metrics would be significantly important however $I_4$ might be the least considered. HDI may be considered a good proxy for political stability for nations following the MI approach.<br><br>They would perhaps like the functioning of the energy market to be included somehow as indicative of diversity of suppliers. | $I_1$: would indicate that sources of fuels and suppliers both need to be addressed. Would attempt to work on the energy market to gather energy supplies from as many sources as possible. Would not be hesitant to try and find new sources of energy.<br><br>$I_2$: High levels of import dependency would be problematic only if the sources are deemed to be unstable (as addressed in part $I_3$). However as long as there are rules or international organizations ensuring that contracts are met and obligations fostered they would not be too concerned about import dependency. However it would prompt development of new alternative sources of energy that could be produced locally.<br><br>$I_3$: Political stability in supplying nations would be a great consideration for MI nations. Many policies would be aimed at improving this to ensure a secure supply of energy from exporting nations.<br><br>$I_4$: MI nations would feel little can be done in this regard and would look to diversify sources of energy as much as suppliers. If there is no viable alternative trading partner there will be little that can be done other than finding new energy sources.<br><br>Absolute gains can be assessed and vulnerabilities only dealing with diversification can be assessed. | ***Acceptability***<br>**Promoting renewable energy** which reduces import dependency and share in TPES of other imported fuels.<br>***Affordability***<br>Not considered in the measure and therefore and policy tools relating to affordability would not influence the results of the measure.<br>***Accessibility***<br>Would improve the value of the index by working on political stability via the HDI. This would be addressed through **foreign policy tools** (e.g. foreign direct investment, aid, free trade etc.)<br>**Diversification,** suppliers and sources. | In the MI approach nations would try to work with the supplying nations in order to improve the political stability of supplier countries. This could be through numerous tools in foreign policy, either bilaterally or through international institutions. The terms of agreements can be conditional in an effort to ensure human development (which is correlated with political stability).<br><br>Renewable energy would be more acceptable then alternative sources of energy such as nuclear power due to their green credentials. These would aid in improving overall diversity of sources of fuel. However promoting nuclear may provide clashes with acceptability goals. |

| S/D Index | | | | |
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| | DESIGN CONSIDERATIONS | INTERPRETATIONS | POLICY TOOLS | POLICY CONSIDERATIONS |
| **Regions and Empires** | The design considerations for this index are very complex. As mentioned before the subjective portions are within the scoring rules and the weighting.<br><br>To go in depth in the scoring rules would be another paper in itself but if one were to conduct this study for a RE nation they must take this into consideration when going over the scoring rules and adjust the rules accordingly.<br><br>With regards to the weighting when it cannot be done objectively RE ideology comes into play. The supply branch may be given a larger weighting if it is felt that there is little that can be done in terms demand management.<br><br>Imports may have different weights for the country that supplies the fuel, to allow for strategic alliances or past cooperation.<br><br>The importance of each sector to an economy will identify the way in which weightings are provided for heating, electricity and transport. Further along the branches the weights may be higher for reliability and adequacy with efficiency not being given so much weighting. | Each branch needs to examined to determine what are vulnerabilities exist.<br><br>For RE nations the focus will be on the supply side. The PES would be the focus and how the imports are secured to ensure as little risk possible from importing fuels. Long term contracts would be desired to reduce the risk with short term dealings.<br><br>The transport of fuels would also be significant due to the importance of transit countries and enhancing import capacity.<br><br>It provides a good inventory of the system but it would be difficult to compare across countries if standard scoring rules are not applied. If the same standards are applied can be used to identify absolute gains. | ***Availability***<br>To diversify and promote energy system flexibility **promoting domestic production of all energy sources** would be a target.<br><br>To allow for more transport and larger import capacity **infrastructure development, development of conversion infrastructure** could be seen as policy tools **Diversification** of fuel sources<br><br>***Accessibility***<br>This would be to addressed by **importing from strategic allies and establishing long term contracts** | Would not look to reduce demand for energy but rather focus on controlling supply and supply risks. Promoting domestic production of energy sources increases the number of fuels that make up the energy mix. Furthermore domestic sources are considered more secure then imported, even if it is imported from strategic allies.<br>Infrastructure development can be both in terms of transport and conversion. Conversion refers to the process by which raw materials are converted into usable energy. If the infrastructure is improved efficiency is improved and less raw materials are required.<br>Transport improvements would have to differ depending the sector in question. The biggest improvements can happen with electricity due to the recent development of smart grids. This allows storage of electricity and increases reliability and import capacity.<br>Infrastructure developments may take place bilaterally or unilaterally to ensure limited use by other nations. This ensures that the country can benefit from relative gains.<br>Diversification would allow for less dependency on single sources of fuel and would spread the risk over a larger amount of energy sources. Diversification of suppliers is also desired, as long as the supplier can be considered a strategic ally.<br><br>Strategic alliances ensure that the importing country benefits from having a secure source of fuel. The strategic alliance can be fostered through foreign, trade, security and economic policy.<br>Developing long term contracts ensures stability in terms of supply and prices and therefore reduces market risks associated with various fuels. |

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| **Markets and Institutions** | Again the scoring rules would need to be examined and be addressed according to the ideology of the nation that is being studied.<br><br>The weighting between supply and demand branches can be affected with regard to MI nations, perhaps giving a larger weighting to demand.<br><br>Rather than having import risks adjusted between EU and non-EU (or regional agreements and non-regional partners) they may wish to have equal risk for politically stable nations that often trade on the energy market as EU (close partner) nations.<br><br>The importance of each sector in the economy again depends on each nation. However environmental or social risks associated with energy sources is not accounted for explicitly. Efficiency may be given a larger weighting as being a major way to be able to improve energy security. Reliability may be given a larger weight as well. | MI nations would probably look to try and influence both supply and demand side vulnerabilities. There would be attempts to reduce the local demand to ensure that overall less energy is required. The industry and transport sectors may be seen as the areas where most changes can take place.<br><br>Conversion and transport as a whole would be of interest but perhaps import capacity would not be seen as something that needs to improve.<br><br>Provides a good inventory of the energy system and identifies potential areas for policies to be developed. Also allows for good benchmarking tools to determine where absolute gains can be made. | ***Acceptability***<br>**Promoting domestic production of renewable energy sources.**<br>**Diversification**<br>Allows for risk associated with fuels to be spread across a greater range and domestic sources are considered to have no risk.<br><br>***Affordability***<br>**Development of conversion infrastructure** would allow for more efficient use of energy sources.<br>**Demand management of** transport and industry sectors **taxes, subsidies etc.**<br><br>***Accessibility***<br>**Diversification** here would be regarding suppliers mostly as well as non-renewable supplies.<br>**Interdependent Relations**<br>**Infrastructure development** regarding multilateral agreements (transit countries) | MI countries would look to manage both demand and supply to ensure a more secure energy system. Demand management would allow a nation to attempt to manipulate the amount of energy demanded by the various sectors. This can be done through taxes, green certificates, subsidies and/or tariffs. This may even be done if it is detrimental to economic growth, in terms of reducing profits of organizations.<br><br>Domestic production of energy would be promoted as domestic production is considered less risky, renewable would be considered more acceptable then alternative fuels such as nuclear or coal. Diversification is applicable both in terms of acceptability and accessibility. Diversification of alternative fuel sources such as bio-ethanol and bio-diesel importation may lead to higher acceptability then traditional fossil fuels, but does not necessarily reduce import dependency.<br><br>Infrastructure development in terms of transport and storage play a role slightly different than that in RE. Smart grids can store energy developed by renewable sources as well as providing an opportunity for energy sharing. Therefore these can be developed multilaterally to share the burden of cost as well as the benefits. The benefits from investments in infrastructure are to provide absolute gains and that is why multilateral actions are considered acceptable. |